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JULY, 1832.

FRANKLIN INSTITUTE.

Explosions of Steam Boilers.

Communication to the Committee of the Franklin Institute, on the Explosions of Steam Boilers, from THOMAS EWBANK, *of New York city.*

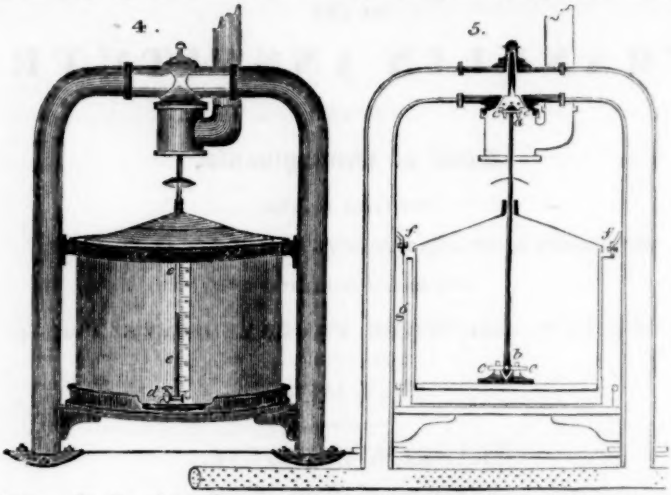
(Continued from p. 369, vol. ix.)

AN improvement in the safety valve, particularly in obtaining and limiting the pressure upon it, is still considered a desideratum. The result of my efforts on this part of the steam engine is the hydrostatic valve published in the last number of the Journal, (vol. ix. pp. 64 and 65,) and to which I beg leave to refer. It combines *both* the valve and gauge with its tell-tale. As a gauge *alone*, for high pressure engines, I think it deserving of attention.

The committee can determine whether the defects of the ordinary safety valve are obviated or not in this device. A simple addition, made to it since the first description was written, may here be mentioned, as it is a still further security against adhesion. A slit *a*, (see fig. 5,) is made in that part of the valve which receives one end of the rod, and a similar one, *b*, on the plate that receives the other end in the bottom of the inner vessel: a short pin, *c c*, is passed through the rod at half an inch from each of its ends, which slip loosely into the slits, (the rod pressing only on its central points,) so that when the inner vessel is moved round, the valve is moved round also with it, even when the steam is pressing against it.

It is often desirable to know the strength of the steam when not blowing off; to ascertain this, the cock *d* (in fig. 4) is opened, and the water allowed to subside until the steam begins to open the valve, when the mark on the glass tube *e e*, opposite the surface of the fluid,

indicates the pressure. The figures just referred to, are given because they represent this valve more in detail than the plate formerly



given. In the plan of the valve, as first described, the liquid was suffered to run over the edge of the outer vessel. Now a rim, *f*, is added, from which a pipe, *g*, (fig. 5) conveys the surplus fluid into the receiver below. This pipe passes down behind the graduated plate shown in fig. 4. The cocks figured in the former plate are dispensed with. The tension of steam indicated by the plate, (see fig. 4) is 50; the surface of the fluid being at that height in the glass tube, and consequently the same in the outer vessel. The rim of the outer vessel is bolted to the steam pipes, to prevent the apparatus from being raised, thus preventing the valve from opening. It has been suggested that the evaporation of the fluid in the outer vessel, would require a constant supply. This supply is abundantly furnished by portions of condensed steam frequently oozing through the valve. (See remarks on the valve, p. 69 of the last volume.)

Should mercury, instead of water, be used, the hydrostatic apparatus should be made of cast iron, and turned smooth; the rim on the outer vessel being made capacious enough to receive the surplus fluid expelled by the opening of the valve. The size of the whole would scarcely exceed one-twelfth of that for water. No cocks in the outer vessel would be required. I have a plan and drawings of one, (including the gauge,) for mercury, but as it has not yet been put in practice, I need not describe it.

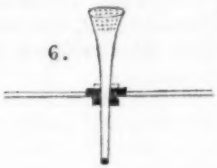
3d. Deficiency of water.—This is directly and indirectly, perhaps, the most frequent source of the injury and of the explosion of boilers. Many boilers have been caused to leak, and others have been rendered useless by being overheated and burned, while little or no water was in them, although no explosion was produced.

A boiler, (the one alluded to in the former part of this communication,) which I erected about three years since, was, when nearly

new, in danger of being destroyed from this cause. The water had been permitted to subside below the flues, and the first intimation of the fact was given by the steam rushing violently out of the steam pipe, at a joint five feet from the boiler, the solder of which it had melted. The covering round the pipe and the packing of the piston were also burned by it. In this instance, the boiler was probably saved by the fusion of the joint. It was made of common plumber's solder, the melting point of which is about 400°.

This circumstance naturally leads the mind to fusible plugs and plates, as the principle on which they act, was fully exemplified in the melted joint. It would appear that some similar mode of applying them would be more advantageous than the ordinary way of placing them in the bottom of boilers.

A very small iron or copper tube, of a tapering form, inserted into a boiler, and having one end closed by a fusible plug, (or a few inches of the closed end formed of the fusible metal,) would answer every purpose of a "tell-tale." The small escape of steam would be no very serious occurrence to passengers, or to the progress of the boat; yet it would be sufficiently so to the engineer to secure his attention. The fusible tube should be *thinnest* where it unites with the other, as in that case it would melt there first, and would then drop into the boiler, leaving the pipe clear. (See fig. 6.) The upper end ought to be closed and perforated with holes to prevent it from being plugged up.

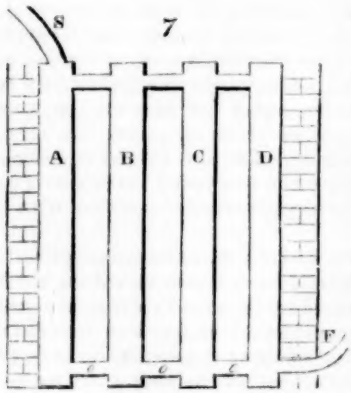

6.

A deficiency of water is supposed by many to have been the primary cause of the dreadful explosion (Sept. 24, 1830,) of a high pressure cylindrical boiler, belonging to Mr. M'Queen of this city: this explosion entirely demolished the large brick building in which the boiler was placed, and killed the engineer, and one other person. The boiler was twenty feet long, thirty inches in diameter, and made of one-fourth inch American iron; it had no interior flues, and was in very little worse condition than when new. It was placed a little below the level of the street, in the lowest floor of the building, its front end facing the street. The fracture took place near the bridge wall, or further end of the furnace, (its hottest part,) and divided the boiler into two pieces. The front end of the boiler, about five feet long, was projected through the front wall of the building, across the street, through the front of a frame house opposite, and lodged in the middle of the second floor. The other piece was found resting on a part of the bed of brickwork in nearly a perpendicular position, with the fractured end upwards.

The line of the fracture was very irregular, not confining itself to the seams, but passing through the middle of one or two of the sheets. The engine was going at an increased speed, so as to attract the attention of Mr. J. M'Laren, the foreman of the foundry, who directed the attendant to slacken it, as the blast of air to the cupola furnace, (the apparatus for producing which the engine was driving,) was too great

at the time. In about five minutes after this, the explosion took place. It is supposed that the attendant had discovered, immediately before the explosion, that there was a deficiency of water in the boiler, and had just opened the communication with the forcing pump, as he was found lying by the feed cock which was open. He might, however, have had the direction of Mr. M'Laren in view in performing that operation, *if the cock were not actually opened before the directions were given.* The appearance of the fractured part gave no indication of the boiler having been burnt, or otherwise injured by the fire. The load on the safety valve, or the tension of steam necessary to raise it, was wholly unknown, and yet additional weights were occasionally added. The attendant had been recently employed on the premises as a labourer, but from his representing himself as having previously had charge of an engine, was permitted to attend it. He is generally believed to have been very incompetent for so important a charge. An unusual difficulty occasionally attended the feeding of this boiler. When the steam was very high, and the water low, the pump could not force the water through the feeding pipe, until it (the pipe,) was cooled by the application of cold water "*to condense the steam in it:*" after the pipe was once filled with water, the supply was continued without difficulty. It would seem from this, that the water must have been very low, or that the feeding pipe did not descend low enough into the boiler; it might, however, have been influenced by the resistance of the heat, which subject, the following observations may still further illustrate.

When several boilers, on the same level, are used together, and fed by a pipe attached to only one of them, (the rest being connected by tubes to the first,) water will not stand on the same level in each; on the contrary, those boilers which are most highly heated, will *always* have the *least* water in them. This fact has been repeatedly, and I think conclusively, established. It has been a common occurrence in the use of those thin rectangular boilers so often used for small stationary engines. Fig. 7, represents a vertical section of a set of these boilers belonging to Mr. Fanshaw of this city, and will serve for illustration. A, B, C, D, show the front end of the boilers; F, the feeding pipe, which terminates in D; C, B, A, are supplied with water from D through the tubes *o o o;* S, is the steam pipe.

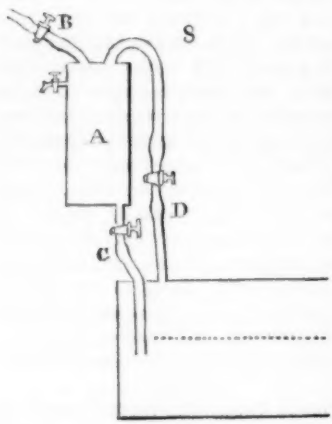


The external sides of A and D are inclosed in brickwork. The fire circulates under and between the boilers, embracing both sides of B and C, but only one side of A and D. Consequently, the temperature of B and C is kept at a higher range

than that of A and D. Now there was always great difficulty in keeping the water *in* the middle boilers, *though none whatever in the others.* It would frequently stand twelve inches higher in them than in B and C, and yet *it had to pass through them to feed* A, (which was always fully supplied:) B and C were also *frequently burnt out*, while the others remained perfect. This is, in my judgment, a very clear exemplification of the great repellent power of heat; the deficiency not being caused, (as was supposed,) from the greater elasticity of the steam in the middle boilers, for the pipes uniting them at their upper parts, would equalize the tension of the steam in all. It presents also a strong admonition to have each boiler (where several are used,) supplied with water independently of the rest.

Mr. Fanshaw adopted this plan, for which a patent was obtained,* and by it has completely avoided the difficulty and danger above mentioned.

In attempting to devise other modes of supplying water to boilers, the most promising in appearance was the following:



A, fig. 8, represents a closed vessel placed above the boiler, so as to be surrounded by the flues of the furnace, after they leave the boiler. This vessel is supplied with water by the pipe and cock B, from a reservoir: the small cock at top is to allow the air and steam to escape for that purpose. The water descends from A into the boiler by the pipe and cock C. The pipe and cock D are to admit the steam on the surface of the water in A to neutralize the pressure of the steam on the mouth of C, after the two upper cocks have been closed.

This apparatus did not answer the very sanguine expectations formed of it. Mr. R. M'Queen, jr. also attached it, in 1828, to one of the boilers in their establishment. It was, however, laid aside as inferior to the pump.

In endeavouring to prevent danger arising from want of water, I have sought for a method of making it known, in preference to any apparatus for supply; because I believe it to be of far more importance to *know when* a deficiency occurs, and how long it remains, than to depend upon any method of supply however excellent in itself. The best of pumps, and other apparatus for the same purpose, may, and do, get out of order, and the difficulty is not to repair *them*, but to ascertain *when* they cease to act. When such is the case, and an engine is in full operation, a very few minutes are of immense

* See Journal Franklin Institute, vol. iv. p. 179.

importance in obtaining a knowledge of the fact, because the approach and increase of danger, then keep pace with the consumption of the steam.

One of the chief obstacles to overcome in attempting to ascertain the true line of the water's surface is from the agitation of the water. Glass tubes have been used to expose it to the sight, but there is a difficulty in keeping them sufficiently clean for that purpose, and they are very liable to fracture. Besides, unless the water be at rest, the apparent line in the glass may be very different from the true level of the great bulk of the fluid.

To the same cause may be attributed the inaccuracy to which gauge cocks are occasionally liable: more especially when inserted through the top of a boiler, or when turned down after entering the sides, portions of water being constantly thrown up into their tubes, and expelled by the steam when they are opened.

Should the tube recommended, (fig. 1, p. 366, vol. ix.) answer the purpose of lessening or destroying the ebullition as supposed, gauge cocks will afford more certainty in their operations.

Floats have been much used in stationary engines, and have been recommended for boilers in steam-boats, but there are too many defects in them as ordinarily used, to permit their being safely relied upon. Their form is defective. The solid float requires to be balanced outside of the boiler, which makes it too complex, and renders it more liable to derangement. The hollow metallic floats are in danger of being collapsed. Both kinds are clogged with the stuffing box, which is sufficient to destroy all accuracy in them. And should a valve be used as recommended by Mr. Cassedy, page 98 of volume ix. the pressure of the steam on the area of the valve would prevent it from being opened. The water might subside, and leave the float suspended in the steam, should the tension of the steam, and the area of the valve, be sufficiently great. I fell into this same error, as may be seen p. 236, vol. vi. Journal of Franklin Institute, fig. 2, which could not pass through Dr. Jones' hands without immediate detection.

The great object in a float, is to make known the least decrease of water, in the shortest possible time after it has occurred. To accomplish this, much depends on the form given to it. That its ordinary form is not the best adapted to this purpose, will be evident from what follows. The solid floats of Bolton and Watt, and, so far as I know, of all others, are in the form of a rectangular prism: their upper and under surfaces being equal, and their sides at right angles to them. Let a float of this description, say twelve inches square, and six inches deep, be properly adjusted to a boiler; and suppose the water to subside one inch below its upper surface, it will then have 144 cubic inches of its contents above the fluid, and its weight consequently increased by that of the same quantity of water: that is, it will preponderate, (deducting friction, &c.) with a force equal to the weight of so many cubic inches of water. Now let another float of the same solid contents and *perpendicular depth* as the above, be made in the form of an inverted cone, (the diameter of its base would

be 23.5 inches,) then let the water subside one inch below its surface, and the contents of the frustum exposed above the fluid, would be 360 cubic inches; consequently, it would preponderate with a force compared to that of the other as five to two; that is two and a half times as great, or, it would have the *same power* to make known a deficiency *before* the water had subsided *one half* the distance. *And this advantage of the cone will apply to all floats, solid or hollow, and whether their specific gravities be greater or less than that of the fluid in which they rest.*

It does appear that if a float could be made, without being subject to the evils before mentioned, it would prove as perfect an indicator of a deficiency of water, as any other apparatus yet devised. The following is a description of one designed to obviate those evils. It is the result of much mental and manual labour, and has consumed the greatest portion of my time for the last two years. I have had it in use for the last ten months, and its accuracy has far exceeded my anticipations. It has never once failed in making known the height of the water when at a certain point, and I do not believe the water can subside one-fourth of an inch below that point without the fact being made known by it, and *that whatever may be the tension of the steam in the boiler.* We work the steam ordinarily at 70 lbs. on the inch. The hydrostatic valve is placed on the same boiler, and is constructed to blow off at 80 lbs.

The committee will be able to judge how far I am under the influence of that partiality to their own productions common to inventors. They will also perceive how far this device is applicable, (if at all,) to boilers in steam boats. I think it could be usefully introduced in those that navigate smooth waters, (if not in all,) as it is not subject to the agitation, or swinging motion of the common float.

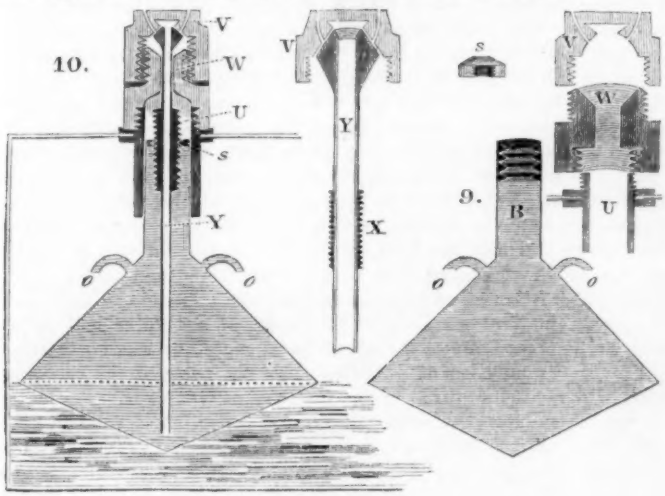


Fig. 9, is a section of the float, being a double cone, that is, two cones united at their bases, made of thin sheet copper. The lower one being the float proper, the upper one terminating in the tube B, which has a female screw formed at its end: *o o* are two short bent tubes, to preserve a communication between the steam in the boiler and the interior of the float; they are preferred to mere holes, as they prevent mud, &c. from falling into the float when thrown up by the agitation of the fluid.

U, is a tube six inches long and two in diameter, securely fixed on the top of the boiler, four inches of its length being inside, and the rest outside of the boiler; a screw is formed on the latter part. The neck of the float or tube B is made to move easily in U, which thus serves as a guide. Y, is a tube rather longer than the depth of the float; a screw four or five inches long is formed on it at X, which fits into the corresponding screw on the neck of the float: a sufficient length is given to X, to adjust by it the float to the required surface of the water in the boiler. S, is a nut to screw on X, close to the top of the float, after it has been united to the latter, to steady them; a collar may be placed between them, to make them steam tight, though this last is not necessary. The lower end of Y reaches to within half an inch of the lowest part of the float. Its upper end is formed into a valve, which is ground air tight to its seat at V; it is made a little spherical to admit of the small motion or play of the neck of the float in U: in the centre of the valve seat, or the part ground, are drilled two small holes, half an inch in diameter, through which the steam escapes, when the valve opens, by the sinking of the water, thus giving notice of the fact.

W, is made to screw on U as represented, it serves as a guide to the part of Y above X: its upper part is formed to receive the under side of the valve, which may be ground to fit it, (the die is not essential,) so that when the valve is opened, *all* the steam which escapes may pass through the float. It is also conveniently separated from U for the purpose of altering or adjusting the depth of the float in the boiler by means of the screw X. The committee will perceive that the pressure of the steam against the valve, is neutralized by its pressing equally (through the tube in the float,) against the valve *seat* at V. The whole of the parts are represented together in fig. 10; the water in the boiler being as high as required, the valve is closed. Suppose the water to subside half an inch, the valve opens and the steam escapes through the float, up the tube Y, and through the small openings at V. I placed over V, a trumpet mouthed organ pipe, the noise of which was so great as to draw the attention of people in the street, (190 feet distance,) who supposed the boiler had burst. I afterwards closed one of the openings as the other was quite sufficient for every purpose of a tell-tale, by the noise of the escaping steam, without the addition of any instrument whatever.

It may be supposed by some persons that water (condensed steam,) would collect in the float and so destroy its buoyancy, but I never found this to be the case, although I have frequently unscrewed W, and taken out the tube Y: indeed, were it to collect there, it would

open the valve by its weight, and be expelled by the steam. This, however, never took place but twice, both of which times the feeding pump had been suffered to work until the water had risen nearly to the small tubes *o o*, when of course it entered the float, but gave immediate notice of the excess of water, by being expelled through the openings at V.

The agitation of the water, has little or no effect on this float; this, however, may be owing to the small size of the boiler and engine. The valve is never opened until the water is on the verge of its prescribed limits, when the valve will alternately open and close, perhaps twice, in the space of a minute, thus giving notice of the approach of a decrease of water. In such cases, a few, say six to eight, strokes of the pump will silence it. After the valve is completely opened, fifty strokes of the pump invariably close the valve. The boiler, as before mentioned, is twenty feet long, and two feet in diameter. The diameter of the feeding pump is two and three-eighths inches, and the length of its stroke six and a half inches. These dimensions, taken in connexion with the facts stated above, show the very small decrease in the depth of the water in the boiler which is made known by this float. The committee will perceive that the float cannot sink more than one half an inch whatever may be the decrease of water in the boiler, as its lower part rests, when opened, that distance upon the corresponding part of W. That distance for the valve to open is abundantly sufficient. The valve itself is only five-eighths of an inch in diameter.

I have made many other floats during the last three years, but this embraces the best features of them all; it is therefore unnecessary to describe them at present.

The last cause of explosions mentioned in the commencement of this paper is neglect. Perhaps every thing that could be said on this subject, has been anticipated in those communications already published by the committee, I therefore pass to the consideration of the means proposed for confining the effects of an explosion to the vicinity of the boiler itself.

For this purpose bulk heads have been strongly recommended. Perhaps they could not be made to impart equal security, to take up less room, &c. better than in the form of an extra boiler, or strong cylindrical casing of iron, inclosing the boiler proper, with a certain space between them. When boilers are placed fore and aft, and on the guards, the end of this casing might be left open. This plan would have important advantages which no bulk heads could possess. The space between it and the boiler, would allow for the expansion of the steam in case of explosion, and by its cylindrical form, the effect would, in a manner, be isolated, and so prevented from expending its energy against the boat. I have no doubt, however, that a steam-boat may be made quite secure without either of these devices.

The different subjects proposed to be embraced in this letter, have now been discussed. I shall be much gratified should my communication contain any thing calculated to prevent explosions, or to increase our confidence in the use of the steam engine, that "noblest work of man."

THOMAS EWBANK.

Continuation of the Report of the Committee of the Franklin Institute of Pennsylvania, appointed May, 1829, to ascertain, by experiment, the value of Water as a Moving Power.

(Continued from p. 377, vol. ix.)

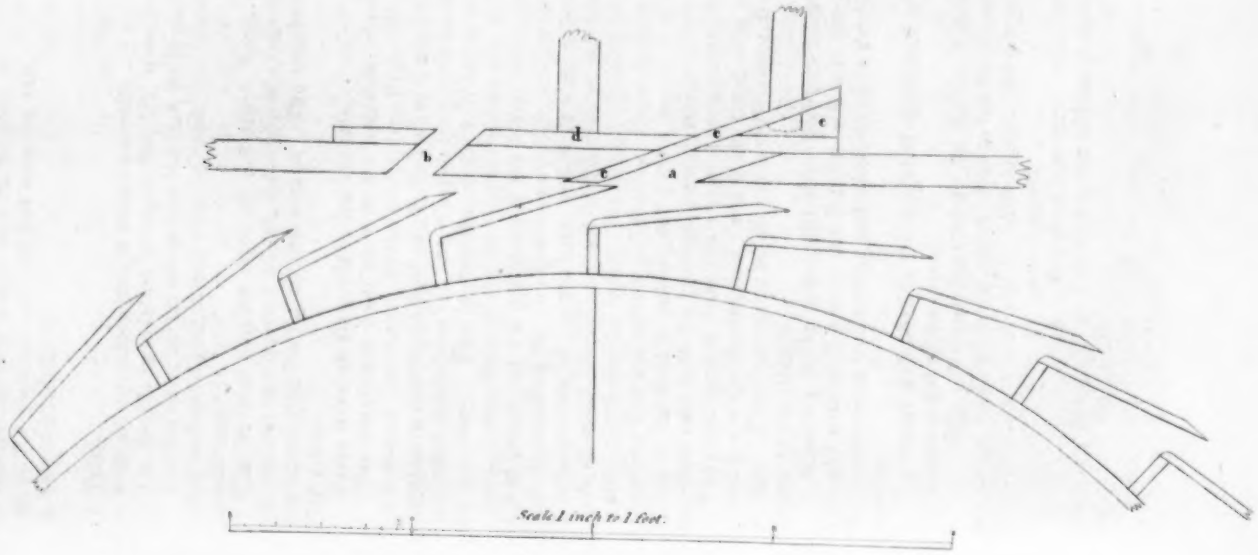
WHEEL NO. III.

The diameter of this wheel was ten feet. The wheel having been substituted for No. II. and the necessary alterations made in the apparatus, the friction of the wheel and drum was examined, and ascertained to be, in each, one per cent. of the weight applied.

The differences of weight which were applicable to the experiments with the larger wheels, would have been too considerable for that under consideration. Variations were made occasionally of fourteen pounds, and usually of twenty-eight, or fifty-six pounds; the leads of 103 lbs. were sometimes used to make up a considerable weight. With small apertures it was found necessary to remove the leads which in the former experiments were contained in the iron basket. The friction table will, therefore, contain instead of the usual constant resisting weight the weight when the leads were removed, and the additional friction for fifty-six pounds, from which that for the different weights is easily obtained.

The weight raised by this wheel was never sufficient to suspend the shaft.

Constant *inactive* weight.		
Weight of the wheel, - -	1600 lbs.	
Weight of that part of the chain which was between the barrel of the shaft and the drum,	264 "	
Weight of the drum, - -	200 "	
Total, - - -	2064 lbs.	
Friction upon this at one per cent. -		20.64 lbs.
Constant *resisting* weight.		
That part of the chain which was between the barrel of the shaft and the ground, -	20 lbs.	
Weight of the iron basket, - -	126 "	
Total, - - -	146 lbs.	
Friction upon this at one per cent. -		1.46 lb.
Friction from *constant weight*, - -		22.10 lbs.
The centre of gravity of the water upon this wheel, (see Fig. 3, Plate V.) was 3.02 feet from the axis, and the barrel about which the chain was wound was one foot from the same axis; hence to raise 146 lbs. and overcome a friction of 22.10 lbs., the constant friction just found, required a weight of water of -	55.66 lbs.	
Friction due to this at one per cent. -		.56 lb.
Total amount of friction when the weight raised was 146 lbs. - -		22.66 lbs.


d
c
e
b
c
a
Scale 1 inch to 1 foot.

Additional friction for every 56 lbs.

Weight,	- -	56.00 lbs.
To balance this weight and its friction, or 56.56 lbs. required, at 3.02 feet from the axis, a weight of water of	- -	18.73 "
Total,	- - -	74.73 lbs.
Friction upon this weight at one per cent.		.75 lb.

The details in relation to wheel No. III. were as follow.

The diameter of the wheel was ten feet, the breadth twenty inches, being sixteen inches in the clear between the cants which were six inches deep.

The buckets applied were of the elbow form, the depth being twelve and one quarter inches, the width of elbow three inches, and the opening at the throat two inches. The number of buckets was thirty-four.

There were no air vents in the buckets.

This wheel was used only as an overshot wheel. Two chutes were placed near the top of the wheel, (see Plate VII.) They were so situated in relation to each other, that when a bucket had just ceased to receive water from the one, it began to receive the water discharged by the other. The inclination of each chute to a tangent to the wheel, drawn through the point at which one side of the chute if produced would cut the periphery of the wheel, was the same. The object of providing the two chutes, was to determine the relative effects of one aperture of a given area, and of two apertures the sum of the areas of which should be equal to the area of the first, all other circumstances being the same. These experiments were suggested by observing that the narrow throat of the elbow buckets prevented their filling in the time of passing one chute, the air in the bucket having no other vent than the passage through which the water entered.

The gates used at these chutes are represented in Plate VII, where *a* and *b* are the chutes, and *c* and *d* are the sliding gates closing the chutes. The dimensions of the parts will be seen from the scale attached to the drawing.

A reference to the tables will show that this wheel was used both with and without a breast, and that in each case the general order of the experiments was similar to that followed in the cases of the other wheels.

The breast extended to the height of three feet and a half above the lowest point of the wheel.

The tables will be designated by the Roman numerals. The experiments made with the wheel close to the breast will be contained in table I, parts 1, 2, and 3. Those with the wheel removed from the breast in table II, parts 1 and 2.

Under the heading " Width of aperture," will be found two columns for the purpose of entering the widths of opening when both the chutes were used.

The height through which the weight was raised, as in wheel No. II, was exactly forty feet.

Table I.—Part 1.

Wheel No. III.—*Elbow Buckets. Close Breast. Water let on at top of wheel.*

No. of Exper't.	Head of water above. Bttm. of gate.	Top of bkt.	Bttm. of bkt.	Width of Aperture a	b	Weight raised.	Friction.	Sum of friction and weight raised.	Height raised.	Time.	Velocity per second.	W't of water expended.	Head and fall.	Power.	Effect.	Ratio, power being 1.	Maximum effect.	Observations.
	Feet	Feet.	Feet.	In.	In.	Pds.	Pds.	Pounds.	Feet.	Scds.	Feet.	Pds.	Feet.					
1	0.25	0.50	1.10		1.50	146	22.67	168.67	40.0	31	6.13	800	10.5	84000	67468	.803		
2						174	23.04	197.04		39	4.87	925		97125	78816	.811		
3						188	23.22	211.22		42	4.52	985		103425	84488	.817	.817	
4						202	23.41	225.41		46	4.13	1055		110775	90164	.813		
5						257	24.14	281.14		54	3.52	1330		139650	112456	.805		
6	0.75	1.00	1.60		1.50	257	24.14	281.14	40.0	27½	6.91	1290	11.0	141900	112456	.792		
7						313	24.88	337.88		34½	5.51	1550		170500	135152	.792		
8						341	25.25	366.25		36½	5.20	1645		180950	146500	.809	.809	
9						388	25.87	413.87		41½	4.57	1900		209000	165548	.792		
10	1.75	2.00	2.60		1.00	257	24.14	281.14	40.0	26	7.31	1255	12.0	150600	112456	.746		
11						285	24.51	309.51		27	7.04	1370		164400	123804	.753		
12						313	24.88	337.88		27½	6.91	1500		180000	135152	.751		
13						341	25.25	366.25		32	5.94	1610		193200	146500	.758	.758	
14						360	25.51	385.51		33	5.78	1710		205200	154204	.751		
15						388	25.88	413.88		34½	5.69	1845		221400	165552	.747		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

TABLE I.—PART 2.

WHEEL No. III.—*Elbow Buckets. Close breast. Water let on at top of wheel.*

No. of Experi.	Head of Water above. Btm. of gate.	Top of bkt.	Btm. of bkt.	Width of Aperture a	b	Weight raised.	Friction.	Sum of friction and weight raised.	Height raised.	Time.	Velocity per second.	W of water expended.	Head and fall.	Power.	Effect.	Ratio, power being 1.	Maximum effect.	Observations.
	Feet.	Feet.	Feet.	In.	In.	Pds.	Pds.	Pounds.	Feet.	Scds.	Feet.	Pds.	Feet.					
16	2.75	3.00	3.60	0.50	0.50	285	24.51	309.51	40.0	26½	7.18	1315	13.0	170950	123804	.724	.724	
17						299	24.69	323.69		28	6.79	1380		179400	129476	.721		
18	2.75	3.00	3.60	0.56¼		257	24.14	281.14	40.0	22½	8.45	1245	13.0	161850	112456	.695		
19						285	24.51	309.51		25½	7.45	1315		170950	123804	.724	.724	
20						299	24.69	323.69		28	6.79	1390		180700	129476	.716		
21	2.75	3.00	3.60	0.62½		271	24.33	295.33	40.0	24	7.91	1305	13.0	169650	118132	.696		
22						285	24.51	309.51		25	7.60	1335		173550	123804	.712		
23						313	24.88	337.88		26½	7.18	1445		187850	135152	.719	.719	
24						341	25.25	366.25		30	6.33	1570		204100	146500	.717		
25						360	25.51	385.51		30	6.33	1660		215800	154204	.714		
26						402	26.05	428.05		33	5.78	1870		243100	171220	.704		
27	2.75	3.00	3.60		0.75	202	23.41	225.40	40.0	21½	8.84	1075	13.0	139750	90164	.645		
28						230	23.78	253.78		24½	7.76	1125		146250	101512	.694		
29						257	24.14	281.14		25½	7.45	1240		161200	112456	.697	.697	
30						285	24.51	309.51		28	6.79	1370		178100	123804	.695		
31	2.75	3.00	3.60		1.00	341	25.25	366.25	40.0	26½	7.17	1675	13.0	217750	146500	.672		
32						374	25.69	399.69		30½	6.23	1800		234000	159876	.683		
33						388	25.87	413.87		30½	6.23	1855		241150	165548	.686		
34						402	26.05	428.05		31	6.13	1910		248300	171220	.689	.689	
35						430	26.42	456.42		33	5.78	2050		266500	182568	.685		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

TABLE I.—PART 3.

WHEEL NO. III.—*Elbow Buckets. Close Breast. Water let on at top of Wheel.*

No. of Exp't.	Head of water above. Bttm. of gate.	Top of bkt.	Bttm. of bkt.	Width of Aperture a	b	Weight raised.	Friction.	Sum of friction and weight raised.	Height raised.	Time.	Velocity per second.	Wt. of water expended.	Head and fall.	Power.	Effect.	Ratio, power being 1.	Maximum effect.	Observations.
	Feet.	Feet.	Feet.	In.	In.	Pds.	Pounds	Pounds.	Feet.	Scds.	Feet.	Pds.	Feet.					
36	3.75	4.00	4.60	0.37½		257	24.14	281.14	40.0	24	7.92	1185	14.0	165900	112456	.678		
37						285	24.51	309.51		25½	7.60	1290		180600	123804	.685	.685	
38						299	24.69	323.69		27	7.04	1365		191100	129476	.678		
39	3.75	4.00	4.60	0.37½	0.25	313	24.88	337.88	40.0	24	7.92	1505	14.0	210700	135152	.641		
40						341	25.25	366.25		25	7.60	1590		222600	146500	.658	.658	
41						388	25.88	413.88		25	7.60	1815		254100	165652	.652		
42	3.75	4.00	4.60	0.50		285	24.51	309.51	40 0	24	7.92	1320	14.0	184800	123804	.670		
43						313	24.88	337.88		23	8.26	1425		199500	135152	.677		
44						341	25.25	366.25		27½	6.91	1530		214200	146500	.684	.684	
45						355	25.43	380.43		26½	7.18	1625		227500	152172	.669		
46	3.75	4.00	4.60		0.62½	257	24.14	281.14	40.0	28	6.79	1275	14.0	178500	112456	.631	.631	
47	3.75	4.00	4.60		0.75	257	24.14	281.14	40.0	22	8.64	1310	14.0	183400	112456	.613		
48						285	24.51	309.51		24½	7.92	1360		190400	123804	.650		
49						313	24.88	337.88		26½	7.18	1440		201600	135152	.670	.670	
50						341	25.25	366.25		29	6.44	1575		220500	146500	.664		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

TABLE II.—PART 1.

WHEEL No. III.—*Elbow buckets. Without Breast. Water let on at top of wheel.*

No. of Exper't.	Head of water above. Btm. of gate.	Top of bkt.	Btm. of bkt.	Width of Aperture a	b	Weight raised.	Friction.	Sum of friction and weight raised.	Height raised.	Time.	Velocity per second.	Wt of water expended.	Head and fall.	Power.	Effect.	Ratio, power being 1.	Maximum effect.	Observations.
	Feet.	Feet.	Feet.	In.	In.	Pds.	Pounds	Pounds.	Feet.	Scds.	Feet.	Pds.	Feet.					
1	0.25	0.50	1.10	1.50		146	22.66	168.66	40.0	38	5.00	960	10.5	100800	67464	.669	.669	
2					1.50	146	22.66	168.66		42½	4.47	1000		105000	67464	.642		
3						174	23.04	197.04		48	3.96	1125		118125	78816	.667		
4						188	23.22	211.22		50	3.80	1200		126000	84488	.670	.670	
5				0.75	0.75	188	23.22	211.22		42½	3.80	1175		123375	84488	.684		
6						216	23.59	239.59		55½	3.80	1320		138600	95836	.692	.692	
7	0.75	1.00	1.60		1.50	216	23.59	239.59	40.0	25½	7.55	1160	11.0	127600	95836	.751		
8						257	24.14	281.14		29½	6.44	1350		148500	112456	.757		
9						285	24.51	309.51		32½	6.04	1450		159500	123804	.776		
10						313	24.88	337.88		34½	5.51	1575		173250	135152	.780	.780	
11						341	25.25	366.25		37	5.13	1725		189750	146500	.772		
12				0.75	0.75	285	24.51	309.51		31	6.00	1490		163900	123804	.755		
13						313	24.88	337.88		32	5.94	1620		178200	135152	.758	.758	
14	1.75	2.00	2.60		1.00	257	24.14	281.14	40.0	25½	7.55	1310	12.0	157200	112456	.715		
15						313	24.88	337.88		33	5.78	1550		186000	135152	.726	.726	
16						360	25.51	385.51		34½	5.51	1800		216000	154204	.714		
17				0.50	0.50	360	25.51	385.51		31½	5.43	1705		204600	154204	.754	.754	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

TABLE II.—PART 2.

WHEEL No. III.—*Elbow Buckets. Without Breast. Water let on at top of Wheel.*

No. of Exper't.	Head of water above. Btm. of gate.	Head of water above. Top of bkt.	Head of water above. Btm. of bkt.	Width of Aperture a	Width of Aperture b	Weight raised.	Friction.	Sum of friction and weight raised.	Height raised.	Time.	Velocity per second.	(W)of water expended.	Head and fall.	Power.	Effect.	Ratio, power being 1.	Maximum effect.	Observations.
	Feet.	Feet.	Feet.	In.	In.	Pds.	Pounds	Pounds.	Feet.	Scds.	Feet.	Pds.	Feet.					
18	2.75	3.00	3.60		1.00	360	25.51	385.51	40.0	29	6.55	1775	13.0	230750	154204	.668	.668	
19	2.75	3.00	3.60	0.50	0.50	360	25.51	385.51		26½	7.17	1690		219700	154204	.702	.702	
20	3.75	4.00	4.60	0.75		341	25.25	366.25	40.0	22	8.45	1600	14.0	224000	146500	.654	.654	
21	3.75	4.00	4.60		0.75	360	25.51	385.51		33	5.68	1825		255500	154204	.604	.604	
22	3.75	4.00	4.60	0.37½	0.37½	360	25.51	385.51		30	6.33	1625		227500	154204	.678	.678	
23						341	25.25	366.25		27	7.04	1570		219800	146500	.667		
24	3.75	4.00	4.60	0.50		257	24.14	281.14		21	9.05	1300		182000	112456	.618		
25						285	24.51	309.51		22	8.64	1400		196000	123804	.632		
26						313	24.88	337.88		24½	7.76	1470		205800	135152	.656		
27						341	25.25	366.25		25½	7.45	1550		217000	146500	.675	.675	
28						374	25.69	399.69		25	7.60	1725		241500	159876	.662		
29	3.75	4.00	4.60	0.37½		257	24.14	281.14		25	7.60	1210		169400	112456	.664		
30						285	24.51	309.51		24	7.92	1300		182000	123804	.680	.680	
31	3.75	4.00	4.60	0.37½	0.25	313	24.88	337.88		24	7.92	1485		207900	135152	.650	.650	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

[TO BE CONTINUED.]

TO THE COMMITTEE ON PUBLICATIONS OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

Reply to the further remarks of Mr. Espy on the application of water upon wheels.

GENTLEMEN,—In the number of this Journal for May last, (No. 5, vol. ix.) are contained certain remarks by Mr. J. P. Espy upon my notice of a critique made by him upon a paper over the signature "L. M." In the course of his remarks Mr. Espy has *conditionally* corrected what I then pointed out as an error which his critique upon "L. M." contained. The condition is, that the "supposition" be erroneous "that water, or any other heavy body, produces the same mechanical effect by moving with a uniform velocity downwards the same distance whatever its velocity may be:" he does not show, however, nor am I able to perceive, how the truth of this supposition (which I hold to be undeniable,) can be made to sustain what he then stated in effect, viz. That when the "velocity of water in the required direction is five and a half feet, immediately on striking the wheel it receives an additional velocity of six and a half feet by a force due to a head of eight inches." I therefore assume that he has not admitted and corrected the error into which I supposed he had "*inadvertently* fallen."

Mr. Espy's mode of using time, instead of space, as an element in his calculations, does not appear to me to be correct, and I must, therefore, reject as erroneous the result at which he arrives, viz. that the whole loss of power will be forty-one inches. On the contrary, if it be admitted that when the water strikes the soaling at an angle of forty-five degrees, the motion (five and a half feet,) in the direction of the radius of the wheel is destroyed, "L. M.'s" calculation would be right. The result of this calculation is a loss of head of thirty-three and one-third inches, instead of forty-one inches as given by Mr. Espy. I do not, however, admit the destruction of the whole of the velocity in the direction of the radius of the wheel, and will endeavour to show that it is *chiefly* changed to the direction of the tangent.

Mr. Espy says, "if we suppose the water and the soaling both perfectly elastic, the water upon striking the soaling would rebound, making the angle of reflection equal to the angle of incidence; and the velocity in the direction of the tangent would evidently remain the same. If we suppose the water and the soaling both perfectly hard and smooth, upon striking the soaling, the motion of the water in the direction of the radius of the wheel would be entirely destroyed, whilst that in the direction of the tangent would remain the same." The first of these propositions I fully admit; but, as the water does not possess the property of perfect elasticity, the angle of reflection will not be equal to the angle of incidence. The last proposition I will neither affirm nor deny, inasmuch as having no materials which are perfectly hard, no experiments have been, or can be made, to prove what would be the result if such materials could be found and

used for the purpose. But I admit that, if instead of the water and the wheel, solid and non-elastic substances, such as do exist, however hard, (none being so hard as to resist a change of form on collision,) were used, the motion in the direction of the radius would be destroyed, and that in the direction of the tangent remain the same. This destruction of motion, however, cannot be effected without the result of a change of form of one or both of the substances thus brought into collision, and the quantity of power expended in the change, will be equal to the quantity of motion or power destroyed. For example, suppose a leaden ball of two pounds be let fall from a height of 100 inches on a hard* non-elastic horizontal plane, and the lower side of the ball be indented, or bruised, so that its mass be brought one inch nearer the plane than where it first struck, the space through which the mass would have passed after contact, would, of course, be one inch, the mean degree of the force of collision would be found as follows: as 100 inches, the distance through which the ball descended, is to two pounds, the force by which it was impelled, so is one inch to 200 pounds, the medium force by which the ball would have been resisted in its collision with the plane; and in like manner if a similar ball be projected against the soaling of a wheel supposed to be hard and non-elastic, the figure of the ball would be changed, and the *quantity* of resistance in the change would be equal to the *quantity* of motion or power destroyed. The result will be very different, however, if water be used instead of the leaden ball, which must be apparent to every person of the slightest observation. Suppose two pounds of water be let fall upon a plane; portions of it will be driven off nearly in the direction of the plane, radiating from the point of impact, at a velocity but little diminished: this velocity must be derived from, or rather is a part of, the original motion, the direction of which has been changed by striking the plane. Had this been a perfectly elastic body it would have rebounded perpendicularly to the height from which it originally fell; had it been a leaden ball its particles would have been prevented by cohesion from flying off, as in the case of the water, consequently its whole motion would have been destroyed by the change of figure, or, in other words, by friction occasioned by the particles pressing upon each other with great force in this movement among themselves. With regard to the water, although its original figure suffers a greater change, yet the frictions *consuming the motion* are diminished, the particles being pressed with less force against each other. Thence, in the case of the lead, the motion was all destroyed, and only part of it in that of the water; what remains in this latter case would, of course, be capable of producing mechanical effect.

This explanation applies to the action of the wheels at Fair Mount, which receive the impulse of the water at an angle of forty-five degrees. We are, therefore, not to expect the motion in the direction of the radius of the wheel to be wholly destroyed, but on the contrary only a small portion of it, because the water will be less agi-

* Hard, is here used comparatively.

tated, or, what is the same thing, the particles will be less moved among themselves than in the case where it fell perpendicularly upon a plane. Thus the water will move off nearly in the direction of the tangent with no other loss of motion than that occasioned by a comparatively small agitation. It is evident, then, that a change of direction, without a corresponding destruction of motion, is not repugnant to any law of nature, and that when it cannot be effected without loss, it must be attributed to the materials made use of, or to the manner of applying them.

Having, as I believe, shown with sufficient clearness that a change of direction may take place under the circumstances in which water is used at Fairmount, without a proportionate loss of motion, it is deemed unnecessary to extend this paper in review of Mr. Espy's deductions from the known laws of action and reaction, &c. His proposition for substituting time instead of space, as an element in determining the power of water, is to me so mystical, that I confess I cannot, or rather, that I have not yet been able to, understand his illustrations in support of it, and must therefore pass it by for the present.

I would be indulged in a few observations upon a subject introduced by Mr. Espy. This subject refers to a former controversy regarding the laws of momentum, in which Mr. Espy maintains, that momentum is proportional to the velocity of a body, and not proportional to the square of the velocity, for which latter law he says I contended.

It will be necessary first to state that I understand the word momentum, to mean the power or capability of a body in motion to produce a mechanical effect by virtue of that motion. For example, if a heavy wheel be in motion, its power to raise a weight by means of a cord connected with its axis, I deem to be the measure of its momentum, the quantity of which may be found by multiplying the weight by the height through which it has been raised. This supposes the wheel to be free from all other resistances. If Mr. Espy's understanding of the term be different from this, our difference in opinion may relate to the meaning of the word momentum alone. With this explanation, I will proceed to apply the theory for which Mr. Espy says I have contended, to a case which he appears to rely upon with the utmost confidence as conclusive in support of a different one. He says, "let two non-elastic bodies, of different masses, meet each other in opposite directions, with velocities inversely proportional to their masses, the momentum of each will be destroyed, for after the stroke there will be no motion." The principle of action here is identical with that of the leaden ball noticed above, and the quantity of power destroyed by the collision is to be found by multiplying the space through which the bodies pass respectively whilst in collision, by the degree of force by which they resist each other. Suppose the masses in motion, and their velocities inversely, to be as one to two, and the velocity of the smaller body to be sixty-four feet, and that of the larger body thirty-two feet per second; then according to the second theory above stated, the momentum of the first may be thirty-two, and the latter sixteen. Suppose that in the

collision they bruise each other so that the centre of their masses be brought three inches nearer to each other than their unaltered form would have admitted, their united momentum, after collision, will be less than before collision by the effect due to a resistance acting through three inches of space, and as "action and reaction are equal," both will be resisted by precisely the same degree of force, but as the smaller body moves with double the velocity of the larger, and both come to rest at the same instant, the first will pass through two inches, the latter through but one inch, after they come in contact. The mean degree of force will be sixteen, which, multiplied by the space two inches, give thirty-two as the quantity of resistance which brought the smaller body to rest, and the larger body being resisted by the same degree of force, to wit, sixteen multiplied by one, the space through which it was resisted, the product is sixteen, which is the momentum destroyed in the large body. As this result appears to be at variance with Mr. Espy's notion of the equality of action and reaction, which is true in *degree*, but not in *quantity*, it may be further illustrated by a very familiar case.

Suppose a gun be discharged, projecting a ball with a momentum capable of perforating a plank two inches in thickness, I believe it will not be contended by any that if a similar ball were attached to the breech of the gun in such manner as to be forced by its recoil against a similar plank, that the latter also would be perforated. The law here is the same as in the case of the smaller and larger bodies noticed above, the action of the powder on the ball would exert a force reacting in an opposite direction and equal in *degree* against the gun, but the *quantity* of force that would be communicated to each, will be as the force multiplied by the space through which the ball and the gun would respectively pass, whilst the force of the powder continues to act on either.

Very respectfully, yours, &c.

C.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.*

On the method of Embalming by the Egyptians, and the Preservation of Dead Bodies from Decay.

It is an established fact in the history of science, that the Egyptians were the first people to rear up the fair temple of knowledge for the abode of those abstract and interesting studies which even at the present day remain sealed to the larger portion of mankind. The sciences of astronomy, the yet more subtle pursuit of astrology, architecture, painting, and medicine, connected with some portion of practical chemistry, were undoubtedly pursued with an avidity as surprising as they were prolific of discovery: and posterity acknowledges the wondrous strength of mind that could force intractable materials to a common purpose, without the aid of the extraordinary adaptation of power which is at our command. It would be an in-

* Addressed to the Committee on Publications, and by them inserted.

teresting task to explore the route of science by the Egyptian way; to track the god-like spirit of intelligence through an æra, dreary and darkened in other respects by the errors of superstition; to follow the beams that emanated from one celestial principle, guiding the will through mazes of doubt, until the light of science burst upon the view; and it would be equally instructive to institute comparison between an ancient and a modern literature, with an intention of ascertaining how far we have retrograded in some instances, and how far we have in others advanced in the pursuit of many of the sciences, and in the cultivation of many of the arts: but, under the title of these remarks, we may not extend our researches beyond the limits of our inquiry, nor is it necessary for the confirmation of the assertion of the skill of the Egyptians, since that one inquiry will display it, not only in a remarkable, but in an inimitable degree. We allude, of course, to the method pursued by that nation in the preservation of their dead by the process of embalming.

It was the belief of the Egyptians that the soul was eternal, but that after the death of the body, it migrated into the various tribes of beings in the earth, air, and water, and once more returned, after an absence of three thousand years, to animate the structure of man. The first change was believed to take place only when the process of corruption was complete, the soul remaining attached to the frame in a state of somnolence so long as the remains of humanity were visible; from this supposition arose the idea of preserving the body from putrefaction for an indefinite period, in order to chain the soul, as it were, to its former abode, and render its flight to other receptacles less rapid, and its changes of less variety. Thus no expense or exertion was spared to stay the progress of putrefaction, no labour withheld in the erection of those majestic fabrics destined for the reception of the bodies yet presumed to retain the silent spirit; and the fortunes of survivers were readily bestowed in the completion of what were termed eternal mansions, while their own dwellings, denominated inns, or resting places, from the short sojourn of the travellers within them, were left comparatively unadorned.

Upon the decease of a person of consequence, the females of his household, and his acquaintances, covered their heads and faces with clay, bared their bosoms, and girt their waists with coarse cloths, and, leaving the body in the dwelling, perambulated the city, uttering loud cries, bewailing the loss of the dead, and describing his qualities, at the same time violently beating their persons. The men, in like manner, formed another company, and pursued a similar mode to testify their grief, all rigidly abstaining, until the interment of the corpse, from the use of the bath, from wine, from the better descriptions of food, and the use of fine apparel. The body was, in the course of a few days, removed to the embalmers, who having performed their office, returned it to the relatives. It was then placed in a coffin of a shape like the human figure, and in general placed upright in the receptacle designed as a tomb. Sometimes by the exercise of a singular species of piety, the corpse was kept in the dwelling of the surviving friends, in a magnificent apartment, prepared

for its reception, and in some instances, the embalmed body was carried as a guest to the tables of friends.

We are told by Herodotus and Diodorus Siculus that the art of embalming was practised in three different modes; the first, required only in preserving the bodies of kings or nobles of the highest rank, cost a talent of silver,* and was thus conducted. The brains were first drawn out through the nostrils by a curved instrument, and the cavity filled with spices. An officer, termed a Scribe, then drew a line on the left side of the abdomen, where an incision was to be made, which was exactly followed by a menial called the Paraschistes, with a sharp Ethiopian stone; this done, he immediately retired to avoid the execrations and violence of the bystanders, who sought in this manifestation of their indignation to ward off the curse which they presumed to await them in permitting a wound to be inflicted upon a dead body.

The office of the embalmers now commenced; one of them thrusting his hand through the wound, drew out the intestines, leaving the heart and kidneys. The abdomen was then filled with pounded myrrh, cassia, and other sweet smelling drugs, frankincense alone excepted, and the incision being closed, was carefully sewed up; the body was immediately rubbed over with oil of cedar, and other preparations, for thirty days successively, or otherwise it was soaked in a strong solution of nitre for seventy days, the longest time allowed for the preparation of the body. At the expiration of this time, the body was carefully washed, and wrapped round with strips of fine linen in every part, which was afterwards covered with a gummy substance.

These arrangements were all performed with the utmost nicety, the hair of the head and the eyebrows were uninjured, and even the features so little disturbed as to permit the recognition of the individual years after his embalmment, in those cases where he was detained from the sepulchre. The second mode was much more simple, and consisted in injecting oil of cedar into the bowels, by the rectum, retaining it there, and placing the body in a solution of nitre, as before, for seventy days; the injection was then allowed to escape, bringing with it the entrails, which the oil had in a great measure consumed. The body was then delivered to the friends without any further preparation.

The third method, which was adopted for poor persons, consisted in merely injecting into the stomach and bowels some preparations of less value than the oil of cedar, and soaking the body in a nitrous solution.

The coffins, or cases, in which were put these preserved bodies, or mummies, as they are styled by the Arabs, and from whom we have borrowed the term, were usually made of sycamore wood, which possesses extraordinary durability; the top was formed in the shape of a human head, with a face painted thereon, resembling that of a female: the trunk was one continuous piece, made very thick, with a

* About $1100.

broad pedestal at the bottom, to enable it to stand upright in the tomb. In some few instances, a stone coffin has been discovered, presenting the same shape, and, in still rarer cases, the covering of the body has been found of cloths gummed or fastened together, and constructed in the usual form.

Upon the examination of a mummy, we find it wrapped in a shroud of linen, or rather a finer fabric than canvass, upon which are secured scrolls of the same material, painted with a variety of characters, and generally running down the centre of the body and sides, or placed on the knees or legs: the head is fitted with a piece of linen, the feet have likewise a similar covering, painted with hieroglyphics, and fashioned in the form of a high slipper. The whole body is swathed with narrow bands of linen, beginning at the head and ending at the feet, to the almost incredible length of upwards of one thousand ells upon one corpse; and those in particular which cover the head and face are so neatly laid on as scarcely to disguise the shape of the eyes, nose, and mouth.

On the breast, are folds of linen cut in a scalloped form, as if to answer the purpose of a breast plate, and which are usually richly painted and gilt, sometimes bearing the figure of a woman with the arms extended. Within the body are found masses, of the colour, scent, and consistence of pitch, or bitumen, which are readily affected by heat; and upon the examination of one body in England, it is recorded that about two pounds weight of this substance was found in the cavity of the skull. The piece of coin that was supposed to be placed in the mouth of the corpse has been looked for in vain, although a small plate of gold of trifling value has been occasionally discovered under the tongue. The hands are sometimes stretched upon the thighs, but more commonly folded across the bosom; the skin blackened, and usually attacked in some parts by a peculiar kind of coleopteral insect, and the hair perfect.

The heart, and, in some instances, other viscera, are found in a dried but perfect state of preservation, and the whole frame is remarkable for its lightness and rigidity.

An opinion has prevailed that the Egyptians possessed the power of extracting the brain, and filling the cavity with a bituminous composition, without mutilating any of the bones of the skull; but this is hardly practicable.

The nostrils offer the only medium through which the brain could be removed without visible marks of injury, and the delicate structure of the cribriform plate of the ethmoid bone would be destroyed by the application of the slightest violence. In all the examinations witnessed by the writer, a probe was readily passed up the nostrils to the roof of the cranium, proving that the brain had been removed by those channels, and that the delicate bones of the skull had been broken down in the attempt. It will thus be seen how perfect the system adopted by the Egyptians for the preservation of their dead was rendered; their work is before us, unattainable to our execution, existing in its pristine excellence, and capable of yet enduring for an illimitable extent of time. And so of many other pursuits: we

can scarcely conceive the ability that could raise so ponderous a mass as the pyramid of Cheops, which might well be termed an eternal mansion, since it has endured so long with the finger of time laid so lightly upon it, as not to have injured its fair and magnificent proportions: and it is equally difficult to imagine, how, in the dearth of correct knowledge, and the want of scientific material, conclusions could have resulted from observations of heavenly bodies so closely allied to truth, as to have assisted in the construction of a solar system, in some respects resembling that upon which our astronomical calculations are founded.

The art of embalming, as practised by the Egyptians, may be said to have expired with them as an ancient nation. In continental Europe, in England, in Teneriffe, South America, Otaheite, and other islands in the southern ocean, processes have been adopted for preserving dead bodies from decay, and in some situations, the soil in which the body has been placed, has acted as the antiseptic agent in staying the progress of putrefaction. Gough, in his sepulchral monuments of Great Britain, observes, when speaking of embalming, "that Henry 1st, in 1135 was gashed, salted, and sewed up in a bull's hide, after his bowels, tongue, heart, eyes and brains had been taken out." This uncouth mode of embalming appears to have been practised in England for a considerable period, although the hide was soon laid aside in favour of cloth, and sometimes of silk or satin coverings, and to have been especially in request to preserve the bodies of sovereigns, and the higher orders of ecclesiastics. Edward 1st, buried in 1320, and found in a state of tolerable preservation in 1714, is said to have been the first monarch upon whom the practice of cering was tried, an operation performed by the Court chandler, and consisting merely in enfolding the royal body in a waxed cloth or silk, after the removal of the viscera. This custom continues to the present time, and is extended to all the members of the royal family.

The remains of Edward the Confessor; of Fair Rosamond; of Maud, daughter of Henry 1st; of Thomas, Bishop of Ely, who died in 1570, and was examined in 1780; of Humphrey, Duke of Gloucester, died 1100 and examined 1747; of king Charles 1st, beheaded 1648, and examined in 1813; of Henry 8th, likewise examined in 1813, (upon the breaking in of his coffin, when restoring that of Charles 1st to its former situation,) have all been exposed, and in different states of preservation. Some of these bodies have been discovered in a species of spiced wine, and others wrapped up in vestments of different descriptions; but, in general, although the structure be not destroyed by corruption, the means adopted have been insufficient to ensure the regularity of appearance, and the preservation of every portion, so remarkable in the Egyptian process.

There are three other methods, which may be styled natural means of preservation, and by which a human body can be withheld from the operation of the putrefactive process, for a very long period of time.

We are presented with examples of the first mode, by the disco-

very of bodies found in the sands of Arabia, dried by the air, the external cavities filled with sand, and preserved entire, without the assistance of art. Of the second, by bodies found on the sea coast, where from long exposure to the sun, and repeated washings by the wave, they become so dry and hard, as almost to present the appearance of a fossil remain. Of the third, by bodies preserved by the peculiar properties of the soil in which they have been deposited. The circumstances under which bodies are preserved by the first two processes are sufficiently simple, and need no remark, but with the third, an event of some notoriety is connected, having too close a reference to our subject to pass unheeded.

Fourcroy relates "that the burying place 'Des Innocens,' at Paris, was opened for the purpose of removing the bodies of the poor which had been buried there in large graves, each holding from one thousand to fifteen hundred, and about thirty feet deep, and twenty feet wide. Each body was buried in a wooden coffin, and all were arranged one alongside of the other: the pit was generally filled in the course of three years, when it was covered with earth to the depth of about a foot, and in the course of from fifteen to thirty years, it was again opened for the same purpose as before. Upon the opening of these graves, and the removal of the covers of the coffins, the bodies appeared to be flattened or pressed down, a considerable space being left between their surface and the top of the coffin. Those bodies that had been buried for about fifteen years, consisted of a soft grayish-white coloured substance, of a fatty nature, bearing a considerable resemblance to spermaceti, into which every part of the body was converted, except the bones, which, being no longer retained by their former attachments, were separated by the slightest effort, they were also very easily broken, while the muscles, tendons, ligaments, blood-vessels, viscera, &c. were changed into a homogeneous mass; perfectly uniform in its texture. In those instances, when the bodies had only been buried nine or ten years, the form of the different parts was distinctly visible. It is said that this appearance is retained for thirty or forty years, when it is at length decomposed and carried away by the surrounding moisture. According to the prevailing opinion, the skin passes more readily into adipocere than any other substance, and is next followed by the muscles and viscera." After these remarks, it may be observed that when a body is interred in a soil of the nature to accomplish such results, and a large quantity of moist earth is present, the common putrefaction that animal matter undergoes, rapidly takes place, particularly when the temperature is considerable; but if the corpse be placed in a dry situation, where the earth is exposed to the rays of the sun, and becomes quite dry, the fluids are evaporated, and it is converted into a kind of mummy. In the repositories of "Des Innocens," the bodies were excluded from the action of the external air, and left to the spontaneous reaction of their elements.

We have now examined the ancient mode of embalming by the Egyptians, the manner in which bodies were preserved by other nations at a much later period, and the processes adopted by nature in

some cases in preserving her noblest work from decay. There can be little difficulty in awarding the palm of merit, as the productions of all have fallen under the inspection of man; we must confess that the Egyptians infinitely excelled in retaining the semblance of the human form, and in keeping destruction at a distance. We have thus supported the principle with which we started, that in this particular, modern ability is surpassed by the silent testimony of ancient skill.

We shall upon another occasion endeavour to trace the meanings and the references conveyed by the hieroglyphics as appearing on the cases and vestments of Egyptian mummies.

Bibliographical Notices and Reviews.

On the Strength and Best Forms of Cast Iron Beams.

[Continued from p. 389, vol. ix.]

In pursuing the deductions from his experiments our author proceeds to compare together the deflections of beams of the new form under their breaking weights, or, in other words, seeks by comparing the ultimate deflections to determine the law of these deflections when the breadth and length of the beam are varied.

The mode of calculating the ultimate deflections would seem to subject them to errors of variable magnitude; it belongs to experiment to determine whether these may, or may not, be neglected for purposes of practical inquiry.

The method of calculation to which we refer is, to assume the deflections to be proportional to the weights producing them, even up to the breaking weight. Thus, "in experiment 11, 13706 lbs. bent the beam .52 of an inch, and 14462 lbs. broke it. As 13706 : 14462 :: .52 : .55, of an inch, the ultimate deflection." The least consideration will show that after the elasticity of a beam is injured by the weight placed upon it, the deflection must increase in a greater ratio than the weight. The amount of the error introduced may be determined, not very nearly, but with sufficient accuracy to enable us to decide upon the method of calculation, by comparing some of the deflections under the later weights applied to the beams, with the deflections near the breaking point as given by experiment. In the subjoined table we have made such an examination. The first column gives the number of the experiment referred to; the second, the number of pounds which gave the observed deflection in the third; the fourth, the last weight under which the deflection was estimated; the fifth, the deflection under this weight; the sixth, the deflection calculated from the second, third, and fourth columns, supposing the deflections to be proportional to the weights; the seventh, the differences between the observed and calculated deflections; the eighth, the breaking weights to compare with the last weights (in column fourth,) under which the deflections were observed, and upon which the ultimate deflections are calculated.

No. of exp't	Weight in lbs.	Deflection observed.	Last weight for which deflection was observed.	Observed deflection.	Calculated deflection.	Difference.	Breaking weight in lbs.
11	11186	.40	13706	.52	.49	.03	14462
12	16226	.49	16730	.53	.48	.05	16730
15	15393	.33	16401	.53	.33	.20	16905
18	14345	.33	18265	.43	.42	.01	19441
20	18265	.36	22969	.50	.45	.05	23249
21	16697	.42	20617	.54	.52	.02	21009
23	10017	.80	12815	1.08	1.02	.06	13543
24	10017	.53	12087	.63	.63	.00	15129
25	12087	.45	15129	.58	.56	.02	15129
26	15913	.40	21401	.65	.54	.09	22185

It is unnecessary for our purpose to extend this table further. Two of the experiments contained in it, viz. 12 and 25, give the observed ultimate deflections for the breaking weights: the differences in all the cases are by no means so great as to require any other mode of deducing the ultimate deflection to be resorted to.

The conclusions which are deduced from comparing the ultimate deflections of beams having nearly the same ratio of top and bottom rib, are not based upon an amount of experiment which *commands* our assent. To conclusion that the "deflections are as the depths; for the products of the depths and deflections were equal in the two experiments, since $4.1 \times 1.14 = 6.93 \times .67$ very nearly," is derived, directly, from only two experiments, viz. 23 and 26. It, however, is supported by other experiments less directly to the point, and has been shown for the material generally by other experimenters.

The next conclusion contradicts the generally received law of deflection while the elasticity remains perfect, and goes to establish that the ultimate deflections are more nearly as the lengths than as the squares of the lengths. We give the author's reasonings upon this subject.

"2nd. For the ultimate deflection in terms of the length. The mean deflection of the beams in experiments 15, 18 and 20, (in which the span was four feet six inches, and depth five and one-eighth inches,) was .51 inch; and in experiment 24 (where the span was seven feet, and the depth 5.2 inches, nearly same as the others,) the deflection was .79 inch. Hence the ultimate deflection in these was simply as the length; for 4 feet 6 inches : 7 feet : : .51 : .79 inch.

Supposing the ultimate deflections to be inversely as the depth when the length is the same, if we reduce the deflections in experiments 23 and 26, to what they would have been if the depth had been five and one-eighth inches, the deflections from both these would have been .91; for $\frac{1.14 \times 4.1}{5\frac{1}{8}} = .91$ and $\frac{6.93 \times .67}{5\frac{1}{8}} = .91$. The

lengths of the beams here being seven feet, as in experiment 24, the deflections are about one-seventh higher than .71, the quantity which we have just found they should have been, if the deflections had been as the lengths. Comparing likewise the length and deflection in experiment 28 or 31 with those in experiment 32, where the depth was the same, we find that double the length gave there more than three times the deflection.

"From these different experiments we find that the ultimate deflections are in a higher ratio than as the lengths, but are not as the square of the lengths, as is generally assumed.

"3d. The ultimate deflections, we see, are in a ratio somewhat higher than as the lengths; and comparing those in experiments 30 and 33, with that in experiment 32, they appear sometimes to increase faster than the depths decrease. If, however, the ultimate deflections were directly as the length and inversely as the depth, or were higher than in both of these ratios in an equal degree, we should conclude that a beam of double the length and depth of a given one would ultimately be deflected the same quantity as it. To see how this accords with the experiments, we will take the short beams, in experiments 28 and 31, and compare their deflections with those from the beams of double their length and depth in experiments 30 and 33; the ultimate deflections from the small beams were .56 and .59 inch respectively, and those from the large ones were .64 and .63 inch. Whence it appears, that the deflections were nearly, but not precisely, equal; there being, in both cases, a deflection somewhat greater in the larger beam."

Further experiments seem to be wanting to establish this point.

B.

AMERICAN PATENTS.

LIST OF AMERICAN PATENTS WHICH ISSUED IN JANUARY, 1832.

With Remarks and Exemplifications, by the Editor.

1. For a *Cement for Wood, Brick, Stone, and Iron Work;* Richard Walsh, Boston, Massachusetts, January 5.

This cement is to be made by mixing together one quart of ground lime, two of calcined plaster, and three of Roman cement. To these are to be added two pounds of black lead, one quarter of a pound of red lead, and the same quantities of copperas and of litharge.

These ingredients are to be incorporated in boiled linseed oil and spirits of turpentine, in the proportions of one part of the former to two of the latter; and it is said that when brought to a proper consistence for spreading, this preparation will afford a slate coloured cement, calculated to defend the material upon which it is laid from the action of the weather. The colour may be varied by mixing with the other materials any suitable colouring ingredient.

When we read the title of this patent, we expected to meet with a cement for uniting substances together, and not with a mere paint for spreading over surfaces in the ordinary way. As a paint, the

composition is rather heterogeneous; some of the substances named may be left out without any disadvantage, or others may be added without abstracting from the good qualities of the mixture. The patent, however, is taken for the precise compound, and such as it is, those who use it, must purchase a right, or invade the claims of the patentee.

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2. For an improvement in the *Mill Stone for grinding grain;* David Stem, Mechanicsville, Vanderburgh county, Indiana, January 5.

This grist mill is to act upon the well known principle of many paint mills. The runner is to be a cylinder, revolving horizontally, and the bed stone a hollow segment in which it fits, the stones being furrowed in a suitable manner. The bed stone is to be borne up against the cylinder laterally, and the feeding regulated by their greater or less distance apart. There is no claim made, nor is there much room for one.

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3. For an improvement in the *Fanning Mill;* Samuel Fitch, Otsego county, New York, January 6.

The *improvement* here offered consists in putting an eccentric wheel upon each end of the shaft of the revolving fan, which wheels act upon levers, giving motion to the shoe, "which motion is necessary to the cleaning of grain." No more.

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4. For an improved machine for *Breaking and Dressing Hemp and Flax;* Ebenezer C. Chase, Jay, Oxford county, Maine, January 6.

A cylinder four feet in diameter, and two feet long, is to be fluted from end to end, all round, so as to form it into teeth. A block of wood is to be placed above this: this block is to be a cube of two feet on each side, excepting that the bottom is to be hollowed to suit the cylinder, and it is also to be fluted in such a way that its projecting angles, or teeth, may fit into the spaces between those on the roller. The cylinder is to be made to revolve, and to act upon lifters which raise the block, in order to its falling upon the hemp or flax which is to pass between it and the roller. There is a feeding apron upon which the flax or hemp is to be laid, and a delivering apron to conduct it off after it has been operated upon. There is no claim made.

This machine very much resembles the ordinary Dutch brake in its mode of operation, although it differs much from it in form; we do not perceive how it is calculated to do the work better, or with greater facility than many other machines which have been made.

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5. For an improvement in the *Tin Bake Oven;* William Lewis, Franklin, Delaware county, New York, January 6.

The top and bottom parts of this tin oven are to be formed into regular flutes from front to back, in order to reflect the more heat upon

the substance to be cooked; there is also to be a reflecting piece along the front. The sides are to flare out a little, like a Rumford's fire place; the dripping pan is to rest upon three wires crossing the oven, and upon each of its ends there is to be a handle; the whole, so made, constitutes the patent oven.

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6. For an improved *Machine for Cutting Books;* Archibald O. Douglass, city of Philadelphia, January 6.

This cutting press is intended to accomplish the same purpose with that described at page 234 of the last volume; that is, the book is to be supported upon a platform which is capable of being raised or lowered at pleasure, to suit the length and width of the volume; the means of adjusting, as well as many other things in this press, differs however, from that alluded to, as well as from the common cutting press. The patentee calls this a box press, which name it receives from there being side and end pieces strongly framed together, and consisting of thick plank like that used for the cheeks in other cutting presses. Through one of these sides, work the wooden screws which force up a sliding cheek to hold the books; and round the heads of the screws a strap passes which is to operate as a band to cause one of them to turn by turning the other. Whatever may be the general good properties of the press, we are confident that this band will not accomplish the object for which it is intended; this, however, is a point of little importance. The manner of fixing the plough, and of adjusting the various parts, we cannot attempt to describe without a drawing.

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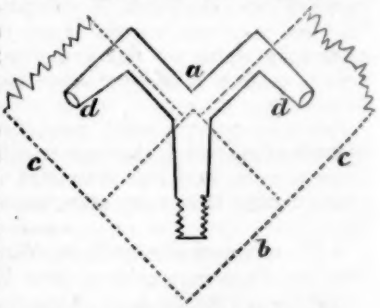
7. For an improvement in *Bedsteads;* Cornelius Vannoy, Lexington, Fayette county, Kentucky, January 10.

Two improvements are here proposed; one of them, in the mode of fastening the rails to the posts, the other in the mode of tightening the sacking bottom. One of the methods proposed for fastening the rails, is similar to such as have been long in use, consisting of a piece on the end of the rail, which passes into an opening on the post, so that by turning the rail they are fixed together by the wedging of the pieces. There is another method stated, which appears to be new. A cast iron hold-fast is to be made in the form of *p*, which is to have its shank fastened into the post *b*. The two hooks, which stand nearly at right angles with each other, are to fit into holes bored in the insides of the rails *c c*. The hook parts *d d* stand a little wedging, and when the rails are driven on to them, their ends, which are worked off square and smooth, are drawn up against the post.



Although this plan is new, we do not think it superior to others previously in use; indeed, we believe that a well made bedstead, with good screws, fitting indiscriminately, is to be preferred to most of the patented fastenings.

The modes of cording the sacking bottoms do not offer any thing particularly worthy of attention, not being better than former plans.

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8. For a mode of *Restoring sour, stale, or musty Ale, Beer, or Porter*, to their original flavour and purity, by the operation of re-brewing; Moses Granger, Louisville, Louis county, New York, January 11.

A mash is to be prepared in the usual way, and the wort drawn off from it. To the malt grains which remain, the sour ale, or beer, is to be added, say to the amount of sixty gallons to forty bushels of grains, and drawn off. This liquor is to be boiled with hops, in the proportion of half a pound to a barrel, after which it is to be put into a clean vessel, and kept for mashing at a subsequent brewing, which, we are told, will restore the liquor to its former state of sweetness and purity.

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9. For an improvement in *Locks;* James Meneely, Watervleit, Albany county, New York, January 12.

All that is claimed by the present patentee is the making the box of the lock, and all the necessary upright pieces within it, of cast iron; the staple or catch, with the necessary screw holes, are also to be cast, as are the bolt, the screw, the key holes, and the wards. For the doing of this, an exclusive privilege is demanded; the claim to *novelty* and *invention*, rests insecurely on such a basis, or we are mistaken in our views of the patent law.

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10. For an *Ice Steam-boat*, for clearing harbours, &c. of ice; Robert Irvine, city of Baltimore, January 12.

Many trials have been made with differently constructed ice breakers, to be worked by steam, but it has been found more difficult to accomplish the object practically, in a harbour or river, than had been anticipated in the parlour. In the plan now proposed we do not see any thing likely to remove the difficulties.

When ice has acquired a considerable thickness, to break and get it out of the way of the boat and paddle wheels, is a very slow process; and to construct and keep a machine in readiness for this purpose alone, requires more remuneration than the few occasions for its employment would be likely to afford.

In the plan before us there is to be a gang of saws in front of the boat, thirteen saws being represented in the drawing. Shanks rise from the upper ends of these saws, by which they are attached to a vibrating frame, as from the nature of the work which they have to perform they must be made sufficiently stiff not to require straining below. The shanks, we are told, should be of round iron, eight feet

long, and six inches thick; the saws three feet six inches long, and an inch and a quarter thick, on their front edges.

An ice breaker, consisting of a plate of iron two inches thick, and extending the whole width of the gang of saws, is placed behind them, and the whole are to be made to vibrate by a crank shaft, acted upon by the steam engine. The saws are to make 100 strokes per minute.

Until this machine is put into operation, and has established its character by success, we deem it needless to say any thing further respecting it, excepting to promise that when this period arrives, we will repair forthwith to the scene of action and report the facts.

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11. For an improvement in *Manufacturing Hats;* Joel Taylor and Charles Brown, Danbury, Fairfield county, Connecticut, January 13.

Rabbit's, or other similar fur and cotton, are to be mixed together, in equal, or other, proportions, and bowed in the usual manner of bowing fur. The bats, or flakes, are then to be wrought by rolling and planking in the usual manner; the dying, stiffening, napping, or covering, are also to be effected in the ordinary way.

The claim is to the mixing of cotton and fur, in the manufacture of hat bodies.

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12. For a machine for *Dressing Mill, and other Stones;* John Keeper, Williamsport, Lycoming county, Pennsylvania, January 13.

A chisel, or cutter, for dressing the stone is fixed on to the end of a handle, which is to be raised by machinery. There is a frame which stands horizontally, and the handle, carrying the chisel, is attached to a shaft crossing this frame at about its middle, and working on gudgeons within it. A cylinder, with cams, or wipers on it, is turned by a crank, the cams acting upon the far end of the handle, lifts it like a tilt hammer, and a steel spring bearing upon the handle near the chisel, or cutter, increases its force in descending. The frame is fixed upon a sliding carriage, allowing it to move backward, forward, or laterally; and a regulating bar across the frame is made adjustable by screws, to determine the depth of the furrows.

When the stone is to be dressed it is secured in a proper position, and the machine adjusted to it. The crank handle is then to be turned, and the proper sliding motion given to the frame. The claims are to "the regulating screws, the regulating bar, and the slides."

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13. For an improvement in the *Plough;* Thomas A. Whities, Bellfontaine, Logan county, Ohio, January 14.

The principal part of the specification of this plough is occupied with the admeasurement of its respective parts; and we are told that "it is composed of wood and wrought or cast iron, and steel." The manner of bracing and putting it together are particularly described; the inventor "believes that it will run much lighter than any now in use, turning over an equally large, if not a larger, furrow, and it may

be used in the foulest land without choaking." To what part it is indebted for those properties which are its recommendation we are not informed, as there is no claim made, or any thing else to indicate the points of novelty.

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14. For a *Machine for bending Felloes for carriage wheels;* Tristram Kimball, Salem, Rockingham county, New Hampshire, January 16.

Pieces for felloes are to be split out, and reduced to a proper size for bending, which is to be effected by the machine. A long ground sill is laid upon cross pieces, and to one end of this a lever is attached by a joint. Upon the sill, near the joint, a shaping block is to be placed; this consists of a piece of wood, the upper side of which is a curve adapted to the inside of the felloe to be formed, and above it, on the under side of the lever, is a follower, concave below, to force the felloe on to the shaping block. The lever is of considerable length, and may be loaded at its extreme end, so that its weight shall suffice to bend the felloe. On the ends of the shaping blocks there are ears, with mortices through them to receive pins, or bolts, which are to confine the felloe upon it after it is bent, allowing one shaping block to be removed, and another substituted in its place as the felloes are bent. A windlass with a rope and pulley, is attached to the lever, for the purpose of raising it. There are various props, braces, &c. which are figured and described, but which we need not notice.

The claim is to "the before described machine for bending felloes for carriage wheels."

The patentee says that the wheels made of felloes so bent, besides being cheaper, are stronger and better than any wheel heretofore constructed. Allowing this to be the case, the patent has nothing to do with wheels thus made, but merely with the machine for bending the felloes; and this may be done as readily by other methods, not interfering at all with "the before described machine."

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15. For an improvement in the *Throstle Frame* for spinning cotton: Seth Simmons, Providence, Rhode Island, January 16.

We have not been able to obtain a clear idea of the details of this throstle frame, although its general structure is sufficiently apparent. There is a drawing, in perspective, very well executed as a picture, but defective in consequence of its not showing distinctly those parts upon which the merits of the invention depend.

We are are told in the specification that the improvement consists in taking the thread from the roller in the centre of the balance flyer, running it thence through the gudgeon and pulley, and then through two holes in the balance flyer, &c. &c. The spindles, instead of being placed vertically, form an angle of forty-five degrees with the horizon; they are denominated independent spindles, being so constructed as to move round either slowly or rapidly in filling the bobbin. This, if we understand the specification, is to be effected by springs of wood, which, by means of thumb screws, may be made to bear

with greater or less force against each spindle. The principle claimed as original is "the method of bearing against the spindle."

If we have communicated a clear idea of this invention, the merit will belong exclusively to the reader, as our own conceptions of it are altogether confused.

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16. For an improved *Surveying Compass;* William J. Young, city of Philadelphia, January 17.

The improvements in the compass, or circumferenter, here patented, are two. The first consists in making the compass plate double, the plates of which it consists turning round upon each other. The circle of the compass is divided in the usual manner; the lower plate is also divided into degrees and parts of degrees, which are hidden excepting at one point, where an opening through the edge of the upper plate exposes them. In this opening there is a vernier, graduated so as to divide the divisions on the lower plate into any required part of a degree. The lower plate is capable of being rendered stationary by means of a screw; and when this is done, angles may be laid off by means of the sights, which may be moved round with the upper plate, without employing the needle for that purpose; thereby avoiding the uncertainty, or the difficulty, attending the process.

The second improvement consists in colouring the surface of the compass plate green, or bronzing it, instead of silvering it in the usual way, thereby relieving the eye from the unpleasant and injurious effects of the white plate. A narrow silvered rim surrounds the bronzed surface, giving a distinct view of the needle point.

Those who are aware of the excellence of the instruments made by Mr. Young, will be prepared to believe that what he denominates improvements are really such, and the result in the present instance will certainly justify the anticipation.

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17. For a *Universal Mill,* for grinding paints, drugs, dye stuffs, corn, rye, wheat, barley, oats, and various other substances; James Bogardus, city of New York, January 18.

In this mill, both the stones are made to revolve, but the upper one receives its motion from that of the lower, in a way to be presently described.

The lower stone is fixed firmly upon a vertical shaft which is made to revolve by the application of any suitable power, and with any required speed. The upper stone is made smaller than the lower, say one-fifth less in diameter, and it is placed so as not to be concentric with it; it may, for example, be so situated that the peripheries of the two stones will coincide on one side, whilst on the opposite side one-fifth of the diameter of the lower stone will be exposed.

The upper stone is kept in its place and its pressure regulated by means of a screw passing through a beam above it, the point of which bears upon a bridge piece in the middle of the eye. It will be at once evident that the revolution of the lower stone will give a slower and peculiar revolution to the upper. A hopper is to rise above the eye of the upper stone, and other requisite appendages are employed.

The claim is to "the manner of placing the upper stone off the centre of the shaft of the lower stone."

Metal, it is mentioned, may, in some cases, be employed instead of the stones for grinding.

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18. For *Sliding Valves for Steam Engines;* Thomas Halloway, Northern Liberties, Philadelphia county, Pennsylvania, January 18.

Side pipes are cast on the cylinder as usual, but so arranged as to adapt them to the particular construction of the slide valves. At each end of the cylinder, over the side pipes, a flat plate is cast, which has three openings in it, arranged lengthwise of the cylinder. They are equi-distant from each other, and the space between them is to be a little greater than the width of the opening. The faces of these plates must be ground perfectly true. The sliding valves which cover them are cast in one piece, being connected together by a stem extending from one to the other. There is an excavation on each of the sliding faces, which embraces two of the openings, and the space between these, forming a steam way from one to the other. Of the three openings at each end of the cylinder, the middle one communicates with the boiler, the inner one with the cylinder, and the one nearest the ends are for escape steam. The excavation in the valve as it slides, covers alternately the centre and inner, and the centre and outer openings. Those acquainted with the action of the engine will at once understand the operation of this valve.

It will be seen that this, like most of the patents taken for steam engines, is a mere point of modification or arrangement; it is, however, more simple than some of the slide valves in use.

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19. For a *Valve for the Vibratory Steam Engine;* Thomas Halloway, Northern Liberties, Philadelphia county, Pennsylvania, January 18.

(See specification.)

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20. For a *Wing Gudgeon Valve for Steam Engines;* Thomas Halloway, Northern Liberties, Philadelphia county, Pennsylvania, January 18.

(See specification.)

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21. For a *Machine for cleansing Paper Pulp,* called the "Piston Pulp Strainer;" James Sawyer, Newbury, Orange county, Vermont, January 21.

This pulp strainer differs entirely in its mode of action from that patented by Thomas L. Woodcock, p. 301, vol. vi. The pulp is put into a mixing tub, within which an agitator is kept in motion; attached to the mixing tub, is another, which the patentee calls the cellar, and between the two there is a part partitioned off, having a piston working up and down in it, which operates as a forcing pump. This piston is to make about fifty strokes in a minute; as it is raised

it admits a portion of the pulp from the mixing tub into the chamber, and as it is depressed, it forces this pulp into the lower part of the second tub, or cellar. Near the upper part of the cellar there is a metallic strainer covering its whole surface, through which the pulp is forced, and from which it runs through a spout into the vat. For an ordinary cylinder machine this strainer may contain about two and a half square feet of surface.

The chamber and piston are so constructed that the latter in raising, during about one-fourth of the stroke, tends to exhaust the cellar, and this draws a portion of the pulp back through the strainer, serving thus to free it from the knots and coarse stuff which would otherwise obstruct it.

The claim is "to the principle of cleaning paper stuff, or pulp, in the way and manner above described; that is, the application of a vacuum formed within or under the sieve or strainer, thereby causing a reaction of water back through the apertures of the sieve or strainer, about one-fourth part of the time, which serves to admit the stuff, or pulp, to flow freely through."

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22. For an improvement in *Cards for Carding Machines;* Edward Faber, Pittsburgh, Allegheny county, Pennsylvania, January 24.

A thin piece of sheet lead, or other metal, is to be laid on one or both sides of the card leather, which is then to be pritched for setting the teeth. The metal, or other material used, may be attached to the leather by glue, cement, or otherwise.

The object of doing this is to render the teeth more stable than when set into leather alone.

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23. For a combined *Clover, Corn Shelling, and Thrashing Machine, with a Grist Mill;* Daniel Mullier, Wooster, Wayne county, Ohio, January 24.

Each of these machines has its separate architypes in the patent office, and elsewhere. The clover machine is a cylinder rubbing against a concave bed; the shelling and the thrashing machines are also cylinders with suitable beaters and teeth, with corresponding concaves; the grist mill consists of iron disks, one foot in diameter, placed vertically, and the whole are fixed on one frame, and driven by bands and whirls. The claim made is to the combination of the several machines named.

With regard to the separate machines, we apprehend that they are all of sufficient age to have entered into public life, and their fathers are probably long since dead. What exclusive right the mere placing them upon the same frame can give to the patentee, we cannot perceive; to us it appears something like a patent for putting each of them into the same barn. New machines, it is true, are generally but new combinations of parts, or instruments, before known: levers, wheels, pinions, axles, cams, weights, and springs, have been long known and used; but they are still capable of new combinations, producing new machines, with new results; and it is this kind of

combination of old things which constitutes the subject matter of a patent. Should I make a machine like that described, but leave out the least valuable part of it, the grist mill, would the patentee still claim it as his combination? we trow not, as this would include the claiming of all the individual machines of which his combined machine is composed.

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24. For a *Machine for making Wrought Nails;* James W. Harvey, Jamestown, Chautauqua county, New York, January 24.

The nail rods are to be heated and passed down perpendicularly through a tube, or guide, between two swedging wheels, or rollers, which have indentations on them to form the edges and heads of the nails, and furnished also with chisels which cut them off of proper lengths. These rollers are made of steel, are ten inches in diameter, and of such thickness as the size of the nail may render necessary. On their lower sides they dip into boxes containing water, to preserve them from being too highly heated. The sides of the nails are to be formed by two other iron rollers, or wheels, which revolve at right angles with the swedging rollers. These are to be four feet in diameter, and are to approach each other sufficiently near to determine the thickness of the nail. All these rollers revolve in a vertical position. We shall not now attempt to describe the accessory apparatus for giving motion to the respective parts, as we deem this unnecessary. The claim is to the large rollers or wheels, for forming the sides of the nails; the swedging rollers, or die plates, not being considered as new.

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25. For an improvement in the mode of *Manufacturing Buck Shot;* John Snyder, city of New York, January 26.

A mould is to be made very similar to those heretofore employed for casting buck shot, or bullets in rows. In the one described, two rows are to be cast at once, there being three bars of brass hinged together at one end. The hemispherical excavations for receiving the lead are made close to the upper edge of the mould, so that the shot may be cast without any neck to it, the opening forming the apex of the shot, as it stands when cast. On the sides, and at one end of the mould, ledges rise to prevent the running off of the lead in casting. The mould being closed it is to be held with its handle end a little elevated, the lead poured on, and allowed to run down towards the hinged end, filling the cavities in its passage: before the metal has set, the lead is to be scraped off the top of the mould with a chisel, leaving the shot separate, and ready to be delivered from it. It is to this last feature that the claim is confined.

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26. For an improvement in the *Self-sharpening Plough;* Bancroft Woodcock, Mount Pleasant, Westmoreland county, Pennsylvania, January 26.

(See specification.)

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27. For a composition of matter to be used in the *Manufac-*

ture of Spruce Beer; George Jones, Boston, Massachusetts, January 27.

From the twigs, boughs, and leaves, of the double white spruce, a material is to be extracted, without boiling or distillation, which the patentee calls "the superior improved oil of spruce, for the making of spruce beer." To form it, two pounds of the leaves, &c. are to be bruised, and soaked for three or four days in alcohol, *of a very high proof.* To every gallon of this, when filtered, three pounds of the essential oil of spruce are to be added: this is the composition for which the patent is taken.

The superiority of this composition over all others, its various uses and great virtues, are enumerated and insisted upon with considerable amplification. To make beer, one ounce of the composition, and one gallon of molasses are to be well mixed together, and two gallons of boiling water are then added; a half barrel is to be used to contain the mixture, and is to be filled up with cold water, when its contents are allowed to ferment.

The process of soaking the boughs, twigs, and leaves in alcohol, and then mixing the infusion with oil of spruce, are the things claimed.

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28. For an improvement in the *Grist Mill;* Gideon Hutchkin, Windsor, Broome county, New York, January 27.

The object aimed at by the patentee, he informs us, is to grind rapidly with small stones without heating the flour; and consequently to lessen the expense of erecting, and the power required for driving such a mill.

A quadrangular frame is to be made in the usual way; on the lower end of the spindle there is to be a projecting rim, or flanch, just above its step, or point; a clutch box, catching above this projection, prevents the spindle from rising. The upper stone is to be the runner, which rests, by means of a balance rine, upon the upper end of the spindle; this being formed hemispherical, and the rine hollowed to suit it. Above the balance rine is a collet and nut, which secure the stone from rising.

The balance rine and driver are to be so formed as to blow wind into the eye of the stone, by their revolution, and channels, or tubes, are to be made to cause currents of air to pass between the stones. By loading the bridge tree, the stone may be forced down, or the top of the spindle may be weighted for the same purpose.

The claims are to increasing the gravity of the runner in either of the ways above named; the inserting wings, or flights; the form given to the driver and balance rine, and the pipes, or channels, for passing currents of air, &c. &c.

The particular forms of some of the parts described in the specification, are no doubt new; in other points, however, the present patentee has trenched upon preoccupied ground. The flanch, or button, at the lower end of the spindle, was particularly described in a patent noticed by us sometime since. Stones also have been loaded

at top, both by direct weights and by levers; and air holes have been made for the purpose of cooling the flour. The claim, therefore, if good, must rest upon the precise manner adopted by the patentee.

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29. For a *Machine for Washing Hats;* Samuel Drinkhouse, Easton, Northampton county, Pennsylvania, January 30.

A wheel six feet in diameter is to be hung by its axle over a trough containing water. Upon each side of the rim of the wheel there are to be pins upon which to place hats, and catches to secure them. A dozen may be placed on each side of such a wheel, and on turning a crank they will be rapidly washed. The whole machine is considered as new, no claim being made.

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30. For a *Piston Safety Valve* for steam engine boilers; John C. Douglass, city of New York, January 30.

The contrivance here proposed is to raise the ordinary safety valve when the steam arrives at a certain pressure, although, from expansion, or any other cause, it may adhere to its seat. The lever of the safety valve is to extend out beyond its prop, or support, on the side opposite to the arm carrying the weight valve, converting it, in this case, into a lever of the first kind: if the extreme end be depressed, the valve, therefore, will be raised. Near this end of the lever, a small cylinder, with a piston working in it, is inserted into the top of the boiler. The piston rod is held down with the required force by a spring steelyard, or by any other measured weight. From the top of the piston rod, a rope, or chain, descends, passes under a pulley, and up to the end of the lever, to which it is attached. When the force of the steam suffices to raise the piston, the end of the lever is, consequently, drawn down, and the opposite end, carrying the safety valve, is raised.

It is much to be doubted whether such an apparatus would generally accomplish the end proposed. The force by which the piston is held down must in but a small degree, exceed that at which the safety valve ought to rise, as it must act as soon as the valve itself ought to operate. When a valve adheres, as it sometimes does, with very great force, the extra elasticity which will enable the patented apparatus to overcome this adhesion, is replete with danger to the boiler, upon the whole interior of which its power is operating. It is to be borne in mind also, that although explosions do no doubt sometimes take place from the adhesion of the safety valve, this is not the only, nor indeed the most frequent, cause. Admitting, therefore, that the apparatus in question would always answer the purpose of its construction, it still must not be depended upon as affording any thing like perfect security. There is another circumstance which will militate against this apparatus, and which is inherent in the use of a steam-tight piston. The amount of friction to which it is subjected in its cylinder is perpetually varying, and the force necessary to raise it will consequently differ at different times; upon

the whole, therefore, we are led to the conclusion that this contrivance will not effect the object for which it was made.

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31. For an improvement in the *Truss for Vessels;* Jonathan T. Quimby, Belfast, Waldo county, Maine, January 30.

So far as we are judges of nautical affairs, this truss appears to present advantages over those of the common construction. We cannot describe it without a cut, but the claim will show the nature of the improvements which the inventor believes that he has made. The hoop which encircles the mast is connected to the yard hoop by means of what is called a truss-bow, attached to wings or ears on the former. The yard hoop swivels on this bow by means of a socket joint. The claim is to the truss-bow, which is so constructed that it will not, in any position of the yard, interfere with the launching, sending up, or housing, of the top-mast. "The connexion of the hinge and swivel joints, which, as constructed, brings the centre of motion within two inches of the yard, so that when the yard is braced sharp to the wind it is not carried to the leeward any more than a distance equal to half its diameter, and consequently may be much more easily and quickly squared."

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32. For a *Machine for Thrashing Rice and other Grain;* Orlando Hurd, Bridgeport, Fairfield county, Connecticut, January 31.

The cylinder and concave of this thrashing machine are to be covered with plates of cast iron, having spurs, or teeth, cast on them, to operate in the usual way. In its form and construction it is like the greater number of its elder brethren, some of which also have had teeth of cast iron. The patentee does not make claim to any thing new in it.

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33. For an improved *Method of Generating power by High Steam;* Benjamin Phillips, city of Philadelphia, January 31.

Should it appear that the patentee of this improvement has really accomplished what he professes, his steam engine will be invaluable, as he informs us that he has invented a "method of generating power by high steam with perfect safety, and without danger of human or animal life, and without risk or possibility of explosion either of the boiler or generators." This he proposes to accomplish by a new and original plan of applying the fire; a new plan of constructing furnaces and generators, and other points of novelty.

The specification does not very distinctly explain the particular construction of some parts of the apparatus, nor do the references to the drawings supply the deficiency. There are in fact several figures in the drawings to which no reference whatever is made, and, although not entirely ignorant upon the subject of steam engines, we are not able to divine their use; these, therefore, we must pass over.

The cylinder is to have the usual shape, and the ordinary slide valves; and the improvement of this part consists in using strong cast,

or wrought iron heads, "with spherical surfaces inwards;" meaning, we suppose, that they are to be convex inwards. Coal furnaces are to be used to heat these heads *red hot*, which furnaces may be removed at pleasure. This, we think, is a bad beginning where perfect safety is a main object. There are to be vessels, which the patentee calls *generators*, but which are rather a species of steam chest, as they do not generate steam, but receive it from a boiler. They are to be of the same size with the cylinder, in order that they may contain steam enough to fill it. There must be two of them to supply steam on each side of the piston alternately. The boiler is to be of the low pressure kind, the steam is to pass from it into the generators, which are also to be heated by a coal furnace. It appears, therefore, that low steam is to be generated in the boiler; and that from this it is to pass into the generators, which being highly heated by their appropriate furnaces, are to convert it into high steam; from the generators it is to pass into the *red hot headed* cylinder, where it gets higher still, and is to act upon the piston with great force, and then to escape.

What the piston is to be packed with, and whether its rod is to pass through the red hot heads, we cannot tell, as neither the description nor the drawings enlighten us upon this point.

Another, or, we suppose, a modification of the same engine, is next noticed, but our picture of it would be less distinct than that just given, we therefore decline even to sketch it.

The machine already described, contravenes all our notions respecting the nature of steam, and the correct mode of applying it. This perhaps arises from an obtunded understanding, as the patentee avers that he has "described the foregoing inventions, improvements and discoveries in a true and correct manner, and in as clear a manner, and in as few words as possible to include all the sense and meaning, exact construction, and operation of the machine."

We think unfavourably of heads convex inwards, made red hot, to bear the pressure of high steam; we think unfavourably of the attempt to convert common into high steam, by heated generators, and heated cylinder heads, where no water is present to give the steam greater density; and we think unfavourably of the perfect security of generators which have, or which require, safety valves; because we believe that wherever safety valves are used, the idea of danger is admitted, and that where they are needed, danger does really exist. In fine, the whole of this contrivance appears to us under an aspect so unfavourable, that we should occupy too much space by arraigning its parts individually, whilst we should afford but little satisfaction to any one; we therefore leave it to the test of time and experience, wishing, though not hoping, that all the fond anticipations of its projector may be realized.

Specifications of American Patents.

Specification of a patent for a Valve for the Vibratory Steam Engine. Granted to Thomas Halloway, *Northern Liberties, Philadelphia county, January* 18, 1832.

To all whom it may concern, be it known, that I, Thomas Halloway, have invented an improvement in the construction and arrangement of the valves of the vibratory steam engine, and that the following is a full and exact description of my said invention.

I intend, usually, to place the trunnions or gudgeons upon which the cylinder is to vibrate, at or near its centre; this, however, is not a point of importance, as my principle is equally applicable in all situations of the trunnions, or gudgeons. In one of the trunnions, or gudgeons, there are two openings made for the admission of steam into each end of the cylinder. In the box, pedestal, or bearing, of this gudgeon there are three openings, one of which is in the centre for the escape of steam, the other two are for the admission of steam into each end of the cylinder, respectively. These openings are so arranged that when the engine is at half stroke, they are all closed; and at or near the end of the stroke, one of the openings in the gudgeon is over one of those for the admission of steam, and the other over that for the discharge of steam. This arrangement will be distinctly seen by the aid of the drawings, and the references thereto, deposited in the patent office, and making a part of this specification.

To prevent the raising of the cylinder from its bearing by the pressure of the steam, and to keep the gudgeon in proper contact with the pedestal, I apply a spring on the upper part thereof, or cause a friction roller to press thereon, or make use of any other device which I may prefer.

Among other advantages of this arrangement is the dispensing altogether with packing, the facility of oiling, and the certainty of the valve always remaining steam tight.

What I claim as my invention is the manner and principle of arranging the valves, or the openings for the admission and the discharge of steam, as hereinbefore described.

Thomas Halloway.

A patent was granted to Elisha Bigelow, of Baltimore, on the 6th of November, 1826, for a similar mode of letting the steam on and off in the trunnions of a vibrating engine, and there are others in which the same method is adopted, varying slightly in the mode, but acting essentially on the same principle.

Specification of a patent for a Wing Gudgeon Valve for Steam Engines. Granted to THOMAS HALLOWAY, *Northern Liberties, Philadelphia county, Pennsylvania, January* 18, 1832.

To all whom it may concern, be it known, that I, Thomas Halloway have invented an improvement in the valves of steam engines, which I intend to apply to locomotive operation only, and which is called the "Wing Gudgeon Valve," and that the following is a full and exact description thereof. I intend that the cylinder, or cylinders, to which my valves are applied, shall vibrate, in general, vertically, but this is not a point of importance, its position being governed by circumstances.

The cylinder is to have one large gudgeon, close to which, above and below, is a face plate, or wing, with an opening leading to each end of the cylinder, longitudinally, which face is exactly in the shape of the segment of a circle, as is shown by a model and drawings, deposited in the patent office.

The piece constituting the valve seats is cast about the width of the boiler, with a plate on each side corresponding with the face on the cylinder, and may be circular, or straight, according to the form of the top of the boiler. This valve seat has two distinct openings leading from a double division cock in the centre to the valve seats which the cylinder vibrates against, and passes out in two openings on each side, corresponding to the openings on the plate of the cylinder; and with the vibration of the cylinder it alternately receives and discharges steam.

It will be understood by every competent engineer that both the face of the plate valve seat, and that of the plate on the cylinder, are to be turned perfectly true, and made steam tight, and will be kept up by a spring, friction roller, or weight.

The cock, which has been mentioned, in the centre of this valve seat, and on the centre of the boilers, is to be so constructed that by turning half round, it reverses the power of the engine; that is, it makes the steam side the exhaust side, and vice versa; and it also answers to shut the steam from both engines: [qu. ends.]

What I claim as my invention is the arrangement of the cylinders and valves to a locomotive engine; the mode of fitting the valves; the construction of the cock in the centre to determine the direction of the engine forward or backward; and the simplicity of the whole, not having half the number of pieces when completed that the generality of English engines have.

THOMAS HALLOWAY.

Fig. 1, is the face of that half of the valve which is cast on the cylinder, with openings leading through the steam ways to the two ends of the cylinder.

Fig. 2. A circular plate forming the other half of the valve, faced to fit steam-tight on fig. 1. A, is an opening in it, to receive the trunnion or gudgeon B, fig. 1.

Fig. 3. A side view of fig. 2. C, the edge of the plate. D, a double tube connected with the boiler; the cock E changing either of the tubes into a supply or discharge tube.

Fig. 1.

Fig. 2.

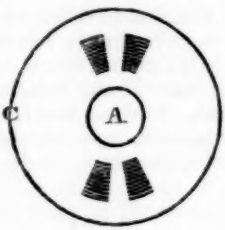
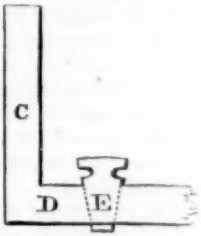


Fig. 3.



Specification of a patent for an improvement in the Self-sharpening Plough. Granted to BANCROFT WOODCOCK, *Mount Pleasant, Westmoreland county, Pennsylvania, January* 26, 1832.

To all whom it may concern, be it known, that I, Bancroft Woodcock, have invented certain improvements in the self-sharpening plough, and that the following is a full and exact description thereof.

In the self-sharpening plough, as heretofore made, the front part of the land side is cast in one piece with the mould board, and as the bottom edge of the land side wears, the part forming the groove into which the coulter slides gives way, and cannot be renewed without renewing the whole casting.

To obviate this objection, I cast the land side separately from the mould board, either in one or two pieces, as may be preferred. When made in two pieces they have a lap joint at or near the middle, which may be secured by a bolt and nut. Suitable holes to receive bolts and nuts, to attach the land side and mould board together, are also provided.

In forming the pattern for the mould board, I make its top to terminate in a standard, or sheath, extending up to the beam, and attach it thereto by a bolt and nut, or otherwise, and in forming the pattern of the land side, the front end of it is made with an arm or piece extending up so as to form a coulter.

For ploughing in rough or stony land I dispense with the coulter as ordinarily made, and substitute therefor what I call a pointed shank, passing it into the groove, and securing it in the same way with the coulter. When I use this, an erect coulter stands in front of it, the upper end of which is secured to the beam in any of the known ways. A hole or depression is made in the heel of the erect coulter, and into this the point of the shank passes, which serves to support and keep it steady. The respective parts herein named will be better understood by reference to the drawing deposited in the patent office.

What I claim as my specific improvement, and for which I ask a patent, is, first, the casting of the land side separately from the mould board, either in one or two pieces, as hereinbefore set forth; and I likewise claim the shank as described, to be used in lieu of the ordinary coulter, with its point entering the heel of the erect coulter in the manner and for the purposes specified.

BANCROFT WOODCOCK.

ENGLISH PATENTS.

Specification of a patent granted to ANGIER MARCH PERKINS, *county of Middlesex, Civil Engineer, for certain improvements in the apparatus or method of heating the air in buildings, heating and evaporating fluids, and heating metals. Dated July* 30, 1831.

To all to whom these presents shall come, &c. &c. *Now know ye*, that in compliance with the said proviso, I, the said Angier March Perkins, do hereby declare the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained in and by the following description thereof, reference being had to the drawings hereunto annexed, and to the figures and letters marked thereon, (that is to say:)

My invention relates to that description of apparatus or method of heating which is now largely employed in heating buildings, and for other purposes, by the circulation of hot water; and the object of my improvements thereon is to obtain considerably higher degrees of temperature to the water circulated, and thus I am enabled to apply my apparatus to a variety of purposes which require the heating medium to be at a higher degree of temperature than that of boiling water. And my improvement consists in circulating water in tubes or pipes which are closed in all parts, allowing a sufficient space for the expansion of the water which is contained within the apparatus, by which means the water will at all times be kept in contact with the metal, however high the degree of heat such apparatus may be submitted to, and yet at the same time there will be no danger of bursting the apparatus, in consequence of the water having sufficient space to expand.

But in order that my invention may be fully understood and carried into effect, I will now describe the drawings hereunto annexed, which represent the improvements applied in various ways.

Description of the Drawing.

Fig. 1 shows the section of the description of furnace I prefer; and fig. 2 is a plan also in section: in each of these figures the same letters of reference indicate similar parts, and such is the case in the other figures in the drawings. The description of tubes which I have used and find to answer, are what are called drawn gas tubing; and the size I most commonly employ is about one inch out-

side diameter, and the diameter of the inner area is about five-eighths of an inch; but I do not confine myself to the use of this size tubing.

Fig. 1

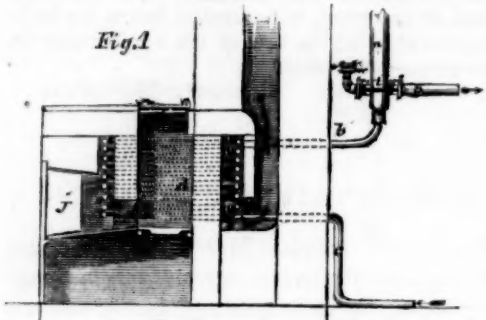
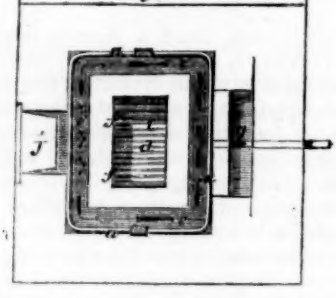
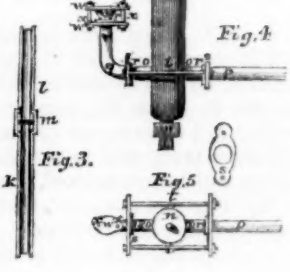


Fig. 2.





In figs. 1 and 2, *a a a* is a coil of tubing, which is placed within the furnace, as shown in the drawing; *b* is a tube by which the water passes from the coil *a*, when in a heated state, and *c* is the tube by which the water is returned to the coil after having given off the heat, to effect the object to which the apparatus is applied, whether for heating the air in buildings, evaporating fluids, or heating metal, as will be more fully described hereafter.

The furnace consists of two compartments *d* and *e;* the compartment *d* is that in which the fuel is burned, and the compartment *e* surrounds that at *d*, and is a sort of hot chamber, into which the coil of tubes *a* is placed, and the water therein becomes heated by the heat which is generated in the compartment *d*, the smoke and heated air passing from the ignited fuel at *f*, into the compartment *e*, and thence into the chimney *g*.

The description of fuel which I prefer is coke, or stone or other coal, as free from bituminous matter as possible, which is put into the compartment *d*, at the upper part at *h*, over which there is placed at all times a cover, to prevent any draft passing in that direction, by which means, when the fire is lighted, and the fuel is filled up to the top of the compartment *d*, and the opening at *h* covered, the air which produces the combustion will pass up through the fire bars at *i*, and

the fuel on such bars will in a short time become an ignited mass: *j* is an opening or door in the front of the furnace, by which the same may be stoked, or the fire lighted.

Figs. 3, 4, and 5, show the manner in which I construct the joints of the apparatus, which are shown on a larger scale for the purpose of making them more clear. Fig. 3 shows in section the manner of connecting two tubes, *k* and *l*; it will be seen that the end of the tube *k* is tapered off both inside and out to a sharp edge, which buts against the straight surface of the end of the tube *l*. On the ends of these tubes are cut screws, the one having a right hand screw, the other a left hand screw, and by means of the coupling piece *m*, which has a female screw cut right and left, the two ends of the tubes *k* and *l* are brought together, and by this means a strong water-tight joint is made, and in this manner I connect any number of tubes together, according to the purpose to which the apparatus is to be applied.

Figs. 4 and 5 are two views of the connexions of other parts of the apparatus, and also of the part of the apparatus which is intended for the expansion of the water; *n* is an upright tube, closed at the top, having a small screw hole to let out the air when the apparatus is filled with water, but which is kept perfectly closed when the air is driven out. This tube *n* is usually made of a larger size than those in which the circulation takes place, and in this tube there should be an area equal to the quantity of expansion which will take place in the water contained in the outer tubes, and as water expands about one-twentieth without being converted into steam, I leave at least double that quantity of capacity in the tube or vessel *n*. *o o* are two short tubes formed into cones at their two ends: these cones enter into holes perforated in the tube *n*, and into the ends of the tubes *p* and *q*, the tube *p* being the one by which the hot water is conveyed from the coil *a a*, after it has become heated, and the tube or pipe *q* is the point at which the apparatus is filled with water, and by which the height of the water is regulated; and this tube *q* is to be placed in such a position that there shall be sufficient space above it in the tube *n*, to allow for expansion.

On the tubes *p* and *q* are two collars *r* formed, and by means of the two plates *s s*, and the screw bolts and nuts *t t*, there will be a strong water-tight joint formed to all the parts. At the top *v* of the pipe, there is a collar *r* formed, and by the plates *w*, and screws and nuts *x*, the cone *y* is strongly held in the opening of the tube *q*, by which the same is made water-tight when the apparatus has been filled with water. To the bottom of the expansion tube *n* is connected the pipe *b*, by similar coupling as that described in fig. 3.

Having now described the manner in which I conceive it best to construct the various parts of the apparatus, I will now proceed to describe some applications of the same. Fig. 6 shows a longitudinal view, and fig. 7 shows a plan of an arrangement for applying my improvements to hot plates which are intended to be used by copper-plate and other printers, for the purpose of heating the plates from which impressions are to be taken. I have not thought it necessary to show the presses, or any other parts of the machinery used for

printing. The plates A A being intended to be used in place of the charcoal fire grates heretofore employed for heating the plates at the time the ink is being rubbed in. One of these heated plates, A, is placed in the proper position at each press, if more than one is to be heated, and it will be evident that a large number of presses may have their plates A, heated by one set of tubes. The tube *p* is the one which, as above described, conveys the heated water from the furnace, and the tube *c* returns it back to the coil after it has given off its heat.

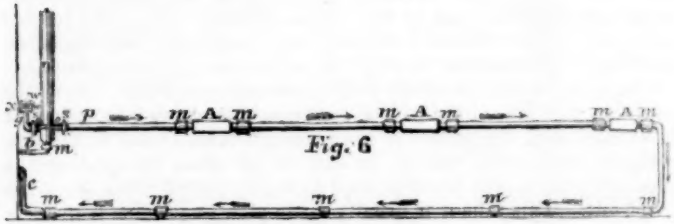


Fig. 6

Fig. 7

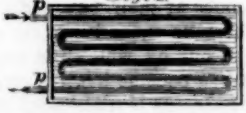


Fig. 8

The manner in which I construct the plates A, is as follows: I make a rectangular mould of the size required, and place therein the bent part of the tube *p*, and then fill the mould with melted lead, or other metal, according to the degrees of heat such plates are intended to bear, by which means I produce metal surfaces, which become heated by the passage of the heated water through the tubes *p*; and it is evident that such heated plates may be applied in a variety of ways, and for a variety of purposes, such for instance as hot plates for cooking purposes.

Fig. 8 shows the manner of applying the apparatus to a rectangular boiler, and which boiler is shown in plan, and is applicable to the boiling of sirop in the making or refining of sugar; by which it will be seen that the heated water is made to circulate through a series of tubes, and give off its heat to the fluid contained in the boiler, or these tubes may be made to pass into steam, or other boilers, in a similar manner, and will cause the fluid contained in such boilers to become heated and evaporated.

In heating the air of rooms of buildings, the tubes *p* and *c* may be made to pass around the flooring of such room, and where a large

quantity of heat is desired, it will sometimes be desirable to have more than one pipe passing to and from the coil of pipes contained in the furnace, whereby a larger quantity of heated surface will be presented, which being heated to a high degree of temperature, will give off the same to the air contained in the room or buildings, and warm the same; and I have found that when the circulating tubes present a surface equal to three times that of the coil of tubes in the furnace, I have not been able to burst the tubes.

Having now described the nature of my invention, and the manner of carrying the same into effect, I would have it understood that I lay no claim to the various parts of which such apparatus is composed. Neither do I claim the application of the circulation of hot water to the purposes above described; but what I claim as my improvements in such apparatus or method of heating the air in buildings, heating and evaporating fluids, and heating metal, consist in circulating water in tubes or pipes, which are closed in all parts, and having sufficient space allowed for the expansion of the water as above described.

In witness whereof, &c. [*Rep. Pat. Inv.*

¶ *Experiments on the Strength of different kinds of Wood, made in the Carriage Department, Royal Arsenal, Woolwich. By Peter Barlow, Jr. As. Inst. Eng.*

The following series of experiments, several of which I attended, being made on species of woods the strength of which has not been previously ascertained, will, I trust, not be considered uninteresting to the readers of the Philosophical Magazine and Annals, particularly as the results are not only curious, but may probably lead to useful and important investigations as connected with the introduction into, and the growth of foreign timber in, this country, as well as to important improvements in the present system of planting. Under this impression I have been induced to send them to you as an addition to the several others on the same subject which have appeared at different times in this Journal. The experiments originated in an investigation of the comparative properties of acacia and oak by W. Withers, Esq. of Norfolk, whose object appears to have been to encourage the planting of the former in many situations instead of the latter, as a wood of great durability, and of quicker growth.

In order to have a comparison made of their relative strength he forwarded specimens of both woods to Woolwich, and the results of the experiments will be seen in the following table. Another question arose with Mr. Withers relative to the strength of oak, the growth of which had been encouraged by culture, compared with oak of the ordinary slow growth.* The specimens connected with the latter subject, the author informs us, were received from Mr. W.

* See a letter to Sir Henry Stewart, Bart. on the improvement in the quality of timber, by W. Withers, Esq.

Boorne, of Erpingham, the one from a fast, and the other from a slow, growing tree. They are marked Nos. 3 and 4 in the table of experiments. The former was grown on a very good strong soil, its age was supposed to be about sixty years, and it contained from thirty-eight to forty cubic feet of timber: the other, No. 4, was about 120 years old, and was grown upon light soil, with gravel about two feet below the surface. This tree contained about eighty cubic feet, but Mr. Boorne considers that if No. 3 had stood to attain the same age, it would have made at least forty feet more than that tree. The other two specimens were from trees furnished by Mr. Samuel Farrow, of Diss, Norfolk, grown on the same piece of land: that from which No. 5 was cut stood near the rack yard of the farm by the side of a ditch, into which ran a great deal of moisture from the yard; and he has no doubt that, independently of the nourishment obtained by it from the ditch, very many of the smaller roots reached as far as the rack-yard: the tree grew rapidly, and contained when cut down 120 feet of timber. The tree from which No. 6 was cut, grew, as before stated, in the same field, but had none of the advantages above spoken of, but still the soil was good with a lightish blue clay bottom. The tree grew well, but not in any degree so fast as the other; it contained about ninety feet of timber, and it is the opinion of persons on the spot that they were both planted together.

Thus far the experiments were made with a particular object; but as there were in store in the Royal Arsenal, many woods not in very common use, but which are grown abundantly in some countries, and from the appearance of which great strength was anticipated, Mr. Bossey, foreman in the carriage department, was requested to prepare specimens, which were submitted to the same test as the former ones.

These results are interesting, some of the woods being more than double the average strength of oak: several of these specimens were sent from Berbice, by Capt. Gipps, of the royal engineers, who speaks very highly of their durability.

The apparatus made use of in the experiments consisted simply of two upright posts, fixed securely at one end in the ground, and at the other to the tie beam of the roof of a shed; on each of these were firmly attached two pieces of hard wood formed to an edge, on which the specimens to be experimented upon were placed, and a scale suspended from the centre to receive weights. To ascertain the relative stiffness or elasticity, the weight which caused a deflection of one inch, was registered. The deflection was denoted by a rod attached to the tie beam, so as to point downwards in front of the middle of the specimen, and one inch below the upper surface; so that when one inch of deflection had taken place, it was shown by the rod just passing clear of the piece under experiment.

In the table, the first column contains the names of the woods; the second the specific gravity; the third the weight which caused one inch deflection, or one-fiftieth part of the length; the fourth the breaking weight; the fifth the relative elasticity from the formula $E = \frac{l^3 w}{a d^3 \delta}$; the sixth the strength from the formula $S = \frac{l w}{4 a d^2}$; where l is

the length, a the breadth, d the depth, δ the deflection in inches, and w the weight in pounds, by which they become comparable with the various experiments in Barlow's Essay on the strength of timber; and the last column contains any requisite description or remarks.

The pieces were each accurately cut and planed two inches square and five feet in length, and the distance of the props on which they were broken was exactly fifty inches; they were selected with great care by Mr. Bossey, who assisted at the experiments, and registered and delivered the following results.

Table of the Strength and Elasticity of various Woods, of English and Foreign Growth.

No. of Exper't.	Names of Wood.	Specific gravity.	Wt. in lbs. which produced 1 inch deflection.	Breaking weight in lbs.	Value of E from the formula $E = \frac{l^3 w}{4 a d^3 \delta}$	Value of S from the formula $S = \frac{2w}{4 a d^2}$	Remarks.
1	Acacia, Eng. growth.	710		1195		1867	
2	——, Do.	710	bore	1084	rope broke	the piece	little injured.
3	Oak, fast grown.	903	660	999	5156250	1561	Specimens supplied by W. Withers, Esq.
4	——, slow grown.	856	414	677	3234375	1058	
5	——, fast grown.	972	550	999	4296875	1561	
6	——, slow grown.	835	439	943	3437500	1473	
7	——, superior quality.	748	896	1447	7000000	2261	Fine specimen.
8	——, Do.	756	680	1304	5312500	2037	In store 16 yrs.
9	Tonquin middle.	1036	1388	2414	10843750	3850	This timber was sent from Berbice by Captain Gipps, R. E.
10	Bean outside.	1080	1332	2228	10406250	3481	
11	Locust middle.	972	1052	2116	8007812	3303	
12	Locust outside.	936	940	2284	7343750	3568	
13	Bullet tree middle.	1029	1360	1724	10625000	2696	
14	Bullet tree outside.	1029	1332	1668	10406250	2606	
15	Green heart middle.	1015	1332	1892	10406250	2956	
16	Green heart outside.	986	1388	1612	10843750	2562	
17	Cabacally middle.	907	952	1668	7437500	2606	
18	Cabacally outside.	892	940	1556	7343750	2431	
19	African oak middle.	972	1168	1447	9132812	2261	From a very fine timber long in store.
20	African oak outside.	972	1168	1643	9125000	2589	
21	African oak middle.	1015	1288	1643	10062500	2567	
22	African oak outside.	972	1097	1643	8570312	2567	
23	American black birch middle.	648	775	1279	6054687	1967	A long time in store, very dry; the same tree.
24	American black birch outside.	633	775	915	6054687	1430	
25	American black birch middle.	648	644	1027	5031250	1604	
26	American black birch outside.	669	831	1433	6492187	2239	
27	Common birch. middle.	792	800	1164	6250000	1820	
28	Common birch. outside.	630	884	1304	6908250	2037	
29	Ash middle.	727	660	1304	5156250	2037	Dry, and of same plank.
30	Ash outside.	702	660	1304	5156250	2037	
31	Elm middle.	554	436	772	3406250	1206	Dry, and of same tree.
32	Elm outside.	532	324	660	2531250	1031	
33	Christiana deal. middle.	698	856	1052	6687500	1644	Dry, and of same deal.
34	Christiana deal. outside.	680	772	940	6031250	1480	
35	Memel deal middle.	590	786	1108	6140625	1731	Dry, and of same deal.
36	Memel deal outside.	590	856	1108	6687500	1731	

It is to be regretted that the results of the acacia were not more particularly noticed; but not having in view at that time to carry on so extensive a course of experiments, means were not taken to ascertain its stiffness. The second specimen, after the rope broke, was found but little injured by the experiment, which certainly indicates considerable power of elasticity, although the exact amount was not numerically ascertained. This specimen was preserved unbroken. Upon the whole, however, it has the advantage of the oaks in strength, except those marked No. 7 and 8, which were remarkably fine specimens; but it will be found by referring to Barlow's Essay greatly to exceed the strength of the oak in general.

The results of the oak experiments seem certainly to be in favour of the fast grown. "These experiments," Mr. Withers observes, "throw new light upon the subject, and lead to the most important conclusions. They prove not only that fast growing timber is superior in quality to that of slower growth, but by the constant application of manure to the roots of trees, planted even in good soil, nearly double the quantity of timber may be obtained in the same period, while its strength, instead of being diminished, will be thereby increased."

[*Phil. Mag. and Annals of Philos., No.* 63, *March*, 1832.

¶ *Observations on Mr. Barlow's experiments on the Strength of different kinds of Wood. By B. Bevan, Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,—I have perused the valuable communication of Mr. Barlow, in your last number, on the strength and elasticity of several species of wood, and join in regret with Mr. Barlow that the experiments on acacia were not complete.

Some time since an opinion was held by some carpenters in Northamptonshire in favour of the superior strength and durability of acacia, and a prime specimen was sent to me for trial. I found it inferior to good oak in strength, and something inferior in elasticity; but as to durability, I am not aware of any proper test; but from the texture and appearance on fracture I should esteem it very inferior.

From my experiments on that species of wood, I can supply the omission in the fourth column of Mr. Barlow's table. The modulus of elasticity of acacia, by my experiments, being 4,560,000 feet, from which it will be easy to deduce the deflection of any scantling under a given pressure, and for the particular case of Mr. Barlow, where $l = 50\, b = d = 2$, and $\delta = 1$, and specific gravity .710, we have $\frac{.710 \times 4{,}560{,}000}{4{,}500} = 720$ nearly for the weight required to produce a deflection of one inch.

It will be observed by persons accustomed to experiments of this nature, that the deflection of one inch approaches too near the ulti-

mate flexure to give a fair measure of the elastic force of the specimen; the average of Mr. Barlow's experiments being nearly two-thirds of the ultimate strain, instead of one-third, which would have been less likely to have impaired the texture of the specimen.

In experiments of this nature it would have been more satisfactory if Mr. Barlow had said something about the *time* during which the specimen was under pressure; as the deflection increases with the time, especially when the load bears so great a proportion to the breaking weight.

Instead of the proportional numbers adopted by Mr. Barlow to express the elasticity, I beg leave to suggest that it would have been more generally useful if the *modulus of elasticity*, had been given. To enable your readers to compare the relative stiffness of the several species of wood in his experiments, I hereby send you the approximate result as deduced by a very simple application of the slide-rule. Thus,

a	4500	Feet modulus of elasticity.
b	specific gravity.	Weight in lbs.

From which it will be found that the mean modulus of the several species of wood in the table of Mr. Barlow will be nearly as follows:

	Feet.		Feet.
Oak	3.303000	American birch	5.295000
Tonquin bean	5.795000	Common birch	5.420000
Locust	4.695000	Ash	4.150000
Bullet	5.890000	Elm	3.135000
Green heart	6.105000	Christiana deal	5.305000
Cabacally	4.730000	Memel deal	6.260000
African oak,	5.532000		

Hence it appears that when compared with their own weight, (although probably the specimens were superior to the ordinary quality,) none of those tried by Mr. Barlow possess a greater degree of stiffness than Memel deal.

It would have added much to the value of the above experiments if Mr. Barlow had given the ultimate deflection. If he has the means of giving this information, it will add to the gratification of many of your readers, and to none more than to your humble servant,

B. Bevan.

P. S. If the price per foot at which the new species of wood above named can be procured, could be communicated, it would be an additional favour.

[*Phil. Mag. and Annals of Philos.*, *April* 1832.

Experiments with the Diving-Bell.—By Thomas Steel, Esq. M. A. Magdalen College, Cambridge.

In 1826 we gave an account of a communicating diving-bell, invented by our esteemed friend and correspondent, Mr. Steele. It consists, as some of our readers may recollect, of two compartments in combination; one of them, the common diving-bell, open at the bottom, the other a close chamber, with a bottom, called by the inventor, "the communicating chamber." The latter is supplied with air by pipes reaching above water, and is separated from the former by a partition, in which is set a small circular window of great thickness and strength, but so transparent as to admit of a person in one chamber seeing distinctly through into the other. Mr. Steele has recently projected some important improvements in this apparatus, a full description of which, from his own pen, we hope in a week or two to be able to lay before the public. With the view in the meanwhile, of preparing the reader to appreciate duly the value of these improvements, we now propose to give, in a somewhat abridged form, an account of the diving-bell experiments which have given Mr. Steele a practical knowledge of those difficulties which it has been his study to obviate, and which, if we are not greatly mistaken, he has obviated successfully. We extract it from the Appendix to Mr. Steele's "Practical Suggestions on the General Improvement of the navigation of the Shannon."

Narrative of circumstances which led to the invention of the communicating Diving-Bell.

Some years ago, I saw, lying near the harbour at Portsmouth, the diving bell which had been made use of by the late Mr. Thompson, when he descended upon the Royal George, sunk at Spithead; he called it his bell of observation, and it was calculated for no other purpose, as it was a close vessel. It was about six and a half or seven feet high, and of a form very like a grape jar. There was a water-tight circular cover that screwed into the top, and there were five small circular eyes, (little windows of strong glass,) of about four inches in diameter, in the circumference of the part where it swelled; and across each of these there was a small bar on the outside, to prevent fracture by impinging while under water upon any hard substance. There were two flexible tubes inserted into the cover by water-tight screws, and through these the engineer, when he descended, was supplied with air, and also held conversation with the persons above water. My curiosity was excited, and I went to Gosport to find out the person, who I was informed had been in the habit of attending upon deck when the bell was under water, to receive orders from below, and have them carried into execution. He afforded me a great deal of very interesting information, and particularly gave me assurance of the distinctness with which the voice could be heard

from under water, and conversation carried on through the tube, which was called the trumpet; the second tube was called the air pipe. The man's name who gave me this information is Wood, and I believe he now works at a shipwright's at Fareham.

In the year 1825 I made, for the first time, as a matter of curiosity, a descent in a common working bell, of course open at the bottom. While I was under water, I was more occupied in making observations on what I saw than in deducing consequences; but after ascending, it suddenly occurred to me, that I could make a great improvement in diving-bells, by combining with the common working bell the bell of observation; for "suppose there was a little window in the bell in which I was down, what would there be to prevent Thompson from looking into it from his bell and telling what he saw?"

Let me, therefore, suppose the two bells to approximate until they coalesce, and have a common side and common window; the engineer in the bell of observation, sitting without pressure from condensed air, and quite at ease, no matter at what depth the bell may be working, will look into a little submarine illuminated chamber, (the bell in which I descended had been illuminated by a lantern;) will see every thing that is doing, and hold conversation with the persons above water.

Thinking one evening afterwards of the violent strain on the chain of suspension, and the consequent danger, when the bell emerging, ceases to have any support from the water, I set myself to work, to find out some method of getting the men out unwet, without the necessity of raising the bell itself out of the water.

A mode of doing this, theoretically possible, quickly suggested itself to me; but one which, in practice, would call to memory the story in Peregrine Pickle, of the gentleman who was remarkable for great mechanical inspiration, and had invented a beautiful machine for cutting cabbages; to the general use of which, however, there was a practical objection, by no means unimportant, namely, that it required the aid of a man and a horse to work it in the cabbage bed.

This theoretical non-impossibility, was as follows: Suppose the bell, (I mean the common working bell,) to be brought to rest upon a ledge, or little platform, projecting horizontally under water from the side of the ship; suppose a tube of a diameter of something less than a yard, bent at an angle, and one leg so much longer than the other, that while the extremity of the shorter leg was placed under, and in contact with the platform, the extremity of the longer one should be above water. Now, imagine the shorter leg to be not merely in contact with, but united to the platform. Let us now suppose a circular hole in the platform over the tube, with an air-tight cover; and let us suppose the longer leg to terminate above water, in an air-tight chamber, with an air-tight door. Now it is quite evident, that if the air chamber and the tube be filled by a condensing air pump, with air as highly condensed as the air in the bell while it rests upon the platform, the circular cover might be unscrewed, and that the workmen might first descend into the short leg, and

then ascend through the long one into the chamber above, and so walk out dry upon deck, without taking the bell out of the water.

This, however, as I have said, was mere theorizing. Still an improvement, possible and practically useful, was the result of this theoretical non-impossibility; for it immediately suggested to me an air-tight chamber on deck, with windows in it like the bell of observation, and connected by a flexible tube with the working bell; and so gave, as an immediate consequence, a second mode of 'communicating,' by conversation, with the persons below.

Experiments with the Communicating Diving Bell—Related by a friend of Mr. Steele's.

The inventor before descending, placed a lighted lantern in the open compartment; he next entered the communicating chamber, through a circular aperture, which was firmly screwed down upon him; and he then gave orders to be lowered under water.

In this descent, the water was prevented from entering the open bell by the ordinary operation of the condensing air-pump upon deck; and Mr. Steele had consequently an opportunity of observing every thing within it strongly illuminated by the lantern; while, at the same time, instead of being obliged to endure the pressure of condensed air, and to depend upon signals by strokes of a hammer, he sat at his ease in air of no greater density than that of the atmosphere, and conversed through one of the pipes with his friends above water.

While he remained down, he described what he saw in the open bell, and gave such directions as circumstances rendered necessary. During this time, by simply turning a cock, he had the means of refreshing the air in his chamber at pleasure, by a current of condensed air from the open bell. After some time, he desired that they should heave up, which was done; the water-tight cover was unscrewed, and he came out evidently very much gratified by the success of his first experiment.

He next took his seat in the open bell, and a bell-man took the place he had just ceased to occupy. The communication between persons descending in this manner, is by writing; they write upon tablets, and mutually exhibit them at the window in the partition. They descended; the bell-man described what he saw to the persons above, and after they had been under water for some time, when Mr. Steele chose to ascend, he intimated his desire to him, and he immediately communicated the order that the bell should be raised. After they came out of the bell, preparations were made for putting the *second* proposed mode of communication to the test.

An air-tight chamber above water, with a window like the one already described, was connected by a flexible pipe with the open diving bell; the bell-man took his seat in this, one of the engineer's workmen went into the communicating chamber, and Mr. Steele himself, taking his tablets and pencil, went into the chamber above water, into which he was immediately fastened by an air-tight cover.

The bell was lowered under water, and of course the chamber above was filled, through the pipe, with condensed air.

At this moment a novel and complex system of communicating by conversation and writing, was thrown into action, instead of signals by the strokes of a hammer. Mr. Steele, in the air chamber above, held conversation with the bell-man below, and the man in the communicating chamber below, conversed with the persons upon the deck of the vessel. A gentleman stood close to the chamber above, and he and Mr. Steele exhibited writings to each other through the window. The latter wrote, among other things, that he had just asked the man below if he was anxious to be heaved up, and that he had been answered in the negative. The men then made some observations about the noise in the bell, caused by the rush of the condensed air through the valve, and about some other circumstances bearing relation to the experiment. At this time, Mr. Steele required some paper, and a sheet tightly rolled was given in to him through a cylinder passing through the side of the chamber. This was furnished with two cocks, one on the inside, and the other on the outside; so that the paper was transmitted without the escape of the air. Soon after this, I observed that he exhibited at the glass, an order for heaving up, and the bell was raised. When he was liberated, and while he was receiving the congratulations of his friends, I heard him say to one of them, that his feeling was one of extreme delight, at the moment when, looking out from the little window of the air-chamber, after the full success of his experiments, he saw his diving bell emerging slowly from the water, and the persons who had descended come out from it in safety.

Note by Mr. Steele.

The men in the working bell under water, are much more comfortable than the person in the air chamber above, although the condensation of the air be in both cases equal, as the air chamber becomes very quickly heated and oppressive, and the window looking out upon deck becomes dimmed so rapidly, that it must be frequently cleared, by rubbing it with a handkerchief. I think (but am not at all sure, not having yet proved it by experiment,) that I see a practical way of preventing this.

There is an exceedingly interesting, but apparently paradoxical consequence, resulting from the theory upon which the air chamber has been constructed. 1st. Let the diameter of the pipe between this chamber and the bell be supposed to be increased until it be sufficient to admit a man, and let a rope ladder be inclosed in it. 2nd. Let the air chamber be subdivided into two, with a man-hole in the partition, and another in the side. It is evident that, by a process analogous to that of passing locks in a canal, and identically the same with that used by Mr. Steele himself, in the transmission of the roll of paper through the two air tight cocks, a man might go down unwet from deck, to blast rocks, or do any other work at the

bottom of the sea! The same thing might be effected by the addition of a third compartment to the bell below, between the communicating chamber and the open bell; in which case, the air chamber above water would (for this particular purpose,) cease to be necessary. It is manifest, however, that these two modes of passing and repassing between the deck and the bottom, might be used even in combination. [*Mech. Mag.*

¶ *Experiments on the Expansion and Contraction of Building Stones, by variations of Temperature; communicated by William H. C. Bartlett, Lieut. U. S. Engineers.*

Fort Adams, Newport Harbour, March 12, 1832.

TO PROFESSOR SILLIMAN.

Sir,—In the progress of this work, we have had occasion to use considerable quantities of coping stones, taken from different localities, with all of which it has been found impossible to obtain tight joints. The walls on which these stones were placed have not undergone the slightest change; and, notwithstanding they were laid with the greatest possible care, and their joints were filled with the best cements that could be devised, yet, at the expiration of a few weeks, these joints were broken up by fissures which extended from the top to the bottom of the coping. These fissures were supposed to have arisen from a change of dimensions in the coping stones, in consequence of the ordinary variations of atmospheric temperature; and, with the view to ascertain if the total amount of cracking could be attributed to this cause alone, a series of experiments was instituted by order of Col. Totten, and continued from August 18th, 1830, to June 2nd, 1831. The circumstances connected with these experiments, as well as their results, you will find subjoined. Col. Totten requests me to communicate them to you, supposing that you may find them of sufficient practical importance to deserve a place in your Journal.

These experiments were made, nearly at the same time, upon granite, limestone, and sandstone, the kinds of stone used for the coping; and for this purpose a piece of each was selected in such a manner that the three pieces were of nearly equal lengths. The granite has a fine grain, is of a compact texture, and was taken from a boulder at the head of Buzzard's bay: the limestone is white, has a fine grained crystalline structure, and accompanies primitive rocks; it was taken from the quarries of the Sing-sing State Prison, New York: the sandstone is from the quarries in Chatham, Conn., and belongs to the old red sandstone formation, according to the Rev. Edward Hitchcock;* it has a granular structure, rather coarse, and its cement is argillo-ferruginous.

* He *now* refers all the sandstone of the Connecticut valley to the new; see the first article in the present No.

To ascertain the exact lengths of these pieces at the different temperatures produced by exposure to the weather—these alone being important for our immediate object, and for the purposes of construction generally,—the measurements were made by means of a white pine rod, with copper elbows at the ends embracing the stones when applied to them, as represented in the sketch.

Fig. 1.

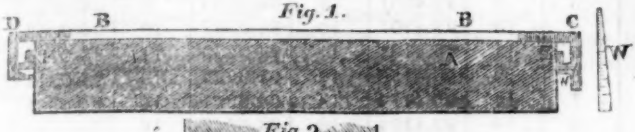
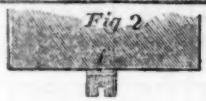


Fig 2



A A is an elevation, or vertical section lengthwise, of the stone to be measured; B B the measuring rod, with elbows, D and C, of thin hammered copper, firmly secured to it. The end D was always adjusted to the same part of the stone, by sliding through a groove in the copper guide F, cemented to the stone; the elbow C was adjusted in like manner by sliding through a groove in the piece E also attached to the stone. The elbow C has itself a groove through which the wedge W may slide horizontally, under the guide E, between the elbow C and the stone: this wedge, being graduated as a diagonal scale, showed, by the distance which it entered, the difference between the length of the measuring rod and that of the stone. The expansion of the measuring rod being known, the length of the stone could be calculated in decimals of a constant unit, viz. the English standard inch.

A groove was cut in the stone in which a thermometer was placed, at each measurement, and being covered, was suffered to lie some time, in order to ascertain the temperature of the stone. The temperature of the measuring rod was assumed to be that of the open air to which it had been exposed.

By Lardner and Kater's Mechanics, we have as a mean between the results of Capt. Kater and Dr. Struve for the linear expansion of deal wood in terms of its length for one degree of Fah. the decimal .00000255; and by the Edinburgh Encyclopædia, art. Expansion, we find the decimal .00000944 to express the same for hammered copper. From these data the actual length of the measuring rod was calculated for each experiment; knowing its length at sixty degrees Fah. But to abridge the calculation, the difference in length between the stone and measuring rod, as shown by the wedge W, was subtracted from the length of the rod before making the reduction for the temperature of the latter. The length of the copper part, and that of the wooden part, were calculated separately on account of their different expansibilities. The result of this calculation is the following table.

MARBLE.			GRANITE.		SANDSTONE.	
No. of Exper't.	Degrees Fah.	Length in inches.	Degrees Fah.	Length in inches.	Degrees Fah.	Length in inches.
1	6°	93.4155	6°	94.0251	6°	94.0180
2	7	93.4277	8	94.0330	8	94.0153
3	9	93.4201	9	94.0260	9	94.0052
4	10	93.4207	10	94.0265	10	94.0088
5	11	93.4131	11	94.0230	11	94.0124
6	12	93.4186	12	94.0282	13	94.0211
7	14	93.4174	14	94.0271	14	94.0206
8	14	93.4294	14	94.0347	14	94.0220
9	14	93.4308	14	94.0361	15	94.0235
10	16	93.4302	16	94.0285	15	94.0238
11	16	93.4291	16	94.0345	17	94.0214
12	17	93.4305	17	94.0358	18	94.0181
13	19	93.4327	19	94.0416	20	94.0239
14	20	93.4310	20	94.0364	22	94.0258
15	21	93.4316	21	94.0440	22	94.0263
16	31	93.4265	32	94.0324	32	94.0371
17	32	93.4352	32	94.0406	34	94.0466
18	34	93.4422	36	94.0330	38	94.0554
19	36	93.4360	36	94.0450	39	94.0436
20	36	93.4357	37	94.0483	39	94.0592
21	38	93.4436	41	94.0344	43	94.0486
22	52	93.4323	52	94.0348	53	94.0560
23	58	93.4450	62	94.0541	64	94.0718
24	83	93.4655	86	94.0720	93	94.0879
25	86	93.4649	88	94.0737	93	94.0829
26	90	93.4709	88	94.0688	95	94.0897
27	99	93.4677	89	94.0731	99	94.0941
28	.	. .	90	94.0693	100	94.0906
29	.	. .	91	94.0693	101	94.0944
30	.	. .	94	94.0628	104	94.0841
31	.	. .	102	94.0721	109	94.0792

It is probable that many of the discrepancies here noticed were owing to the hygrometric state of the stone; and perhaps, in part, to imperfections in the measuring apparatus; but as the hygrometric state of the stone was not recorded, we can take no account of it in our deductions. These discrepancies, however, will have but little effect upon the general result; for it will be observed, that there is always an increase in the length of stone for an increase of temperature, when any two experiments are considered which are removed from each other by several degrees.

From the facts ascertained concerning the expansion of other substances, we may assume that the expansion of stone is uniform, and that, within the range of our experiments, each of the stones increas-

ed in length by a common difference for each degree of the thermometer. To find an approximate value for this common difference, say for the granite, we subtract the first observed length from the last, and, if these experiments were accurate, the difference .0470, would be ninety-six times the common difference: ninety-six being the difference in degrees between the extreme temperatures: the same operation being performed with the second experiment, and that next the last; the difference .0298, (the difference in lengths,) should be eighty-six times the common difference. By thus comparing the extreme experiments of those which remain, we obtain the following table.

Experiments.	Diff. in degrees.	Diff. in lengths.
1 and 31	96	+.0470
2 and 30	86	+.0298
3 and 29	82	+.0433
4 and 28	80	+.0428
5 and 27	78	+.0501
6 and 26	76	+.0406
7 and 25	74	+.0466
8 and 24	72	+.0373
9 and 23	48	+.0180
10 and 22	36	+.0063
11 and 21	25	—.0001
12 and 20	20	+.0125
13 and 19	17	+.0034
14 and 18	16	—.0034
15 and 17	11	—.0034
Total,	817	.3708

We have neglected the sixteenth experiment, because we cannot employ it without using some other experiment twice, thus giving the latter an undue influence; and because the middle term should have the least weight in determining the common difference.

By the above table, we find, as the combined result of all the experiments, that .3708 should be eight hundred and seventeen times the common difference; and hence the common difference for one degree of Fah. is .0004538 inch. Now, assuming 94.05 inches, as the mean length of the granite, which is sufficiently near, we find the linear expansion for one inch of stone for each degree of Fah. to be $\frac{.0004538}{94.05}$ = .000004825 inch, and for one foot this expansion would be .0000579 of an inch. By proceeding in the same way with the experiments on the other stones, we obtain the following results.

Mean whole length in inches.		Common difference in inches for the whole length of stone for one degree of Fah.	Common difference in inches for one inch for each degree of Fah.
Granite,	94.05	.0004538	.000004825
Marble,	93.44	.0005297	.000005668
Sandstone,	94.05	.0008965	.000009532
White pine,		- - -	.00000255
Hammered copper.		- - -	.00000944

To apply these results to the case in question, let us suppose two coping stones of five running feet each, to be laid in mid-summer, when they have a temperature of ninety-six degrees Fah.; in winter their temperature may safely be assumed at zero, so that the total variation of temperature will be ninety-six degrees; and if we suppose these stones to contract towards their centres, which would be the most favourable supposition as regards the tightness of the joints where a number of these stones are used, the whole length of stone put in motion by a change of temperature would be five feet. If the coping be of granite, the distance by which the ends of the stones would be separated, in consequence of *one* degree's variation, would be sixty inches multiplied into .000004825 = .0002895, and for a variation of ninety-six degrees, this distance becomes .0002895 × 96 = .027792 inch, giving a crack a little wider than the thickness of common pasteboard. For marble, this crack would have a width of .03264, nearly twice the thickness of common pasteboard; and for sandstone .054914, nearly three times the thickness of pasteboard. These cracks are not only distinctly visible, but they allow water to pass freely into the heart of the wall. The mischief does not stop here: by this constant motion back and forth in the coping, the cement, of whatever kind the joints might be made, would be crushed to powder, and in a short time be totally washed by the rains from its place, leaving the whole joint open.

[*Amer. Jour. of Sciences and Arts.*

¶ *First Report of the Proceedings of the British Association for the Advancement of Science, assembled at York.*

The appearance of this report has put the scientific public in possession of the authorized account of what has been done by this very important society, and of what may be expected from its exertions.

We cannot but consider that the British Association has started under auspices the most favourable, and even the results of the first meeting, and the prospects of support which this report displays, certainly exhibit a much greater step towards the fulfilment of a great series of objects requiring much time for their development than could possibly have been anticipated.

That the Association has already secured in its favour a great share of the best talent in the country, the list of members annexed to the report will best testify; it is in every respect a most creditable phalanx of names. Fortunately, however, it is not upon names alone, that its prospects of support must rest; the pamphlet before us contains pledges of exertion from some of the most active philosophers in the country, of a description which has been unattempted by any previously existing society among the many which this country possesses. There is no society, strictly scientific, which professes to direct the attention of its members, or of philosophers at large, to particular branches of knowledge, in which important progress might be made by a well directed system of mutual co-operation. Take, for example, the science of meteorology, in which observers have been so long at cross purposes, and in which the very same amount of exertion, which has been thrown away upon forming registers utterly useless for want of information or combined exertion, might have been rendered available to the highest purposes of science. To this subject the Association has properly directed peculiar attention, and, it may be hoped, with the happiest results.

But there is nothing which strikes us with more admiration amongst the energetic proceedings of this infant institution, than the list of reports on the state and progress of the different sciences. This is a species of literature quite new in this country, and which will form a body of information really invaluable. The only approximation to it has been in the annual addresses of the president of the Geological Society upon that particular branch of science. These admirable discourses have only excited the wish that something more general, upon the same plan, should be attempted. The objects of these scientific reports will, we believe, be more varied and extended; and it is probable, that, for the first year at least, the style of execution of them will much depend upon the views and opinions of the individuals by whom they are composed, until some formal plan shall have been sanctioned by usage for general adoption. Some account of the different labours of philosophers during a recent period of time, with a view of their bearing upon the past progress and future prospects of the sciences, will, we presume, be a general object of these reports; but we trust that in many of them more extended and philosophical generalizations will be taken; and in several sciences we do not know a more acceptable service that could be performed, than a correct estimate of the precise point to which our knowledge has arrived, and where precisely our ignorance begins. From this process some conclusion will naturally be drawn as to the line, or lines, which present the fairest points of attack upon the remaining strong holds of science.

The names of those who have engaged to execute these useful labours in science include some of the most active philosophers in Britain; and we anxiously hope that nothing will deter those who have given this capital portion of the machinery of the Association the weight and sanction of their names, from fulfilling, in as full a manner at least as leisure will permit, the agreement to which they are

in some measure pledged, and which will be valuable to science and to the Association, in proportion to the acknowledged eminence of their scientific character.

As we cannot but look upon this as one of the most important parts of the pamphlet before us, we shall insert the list of reports contained in the preface.

"1. The Rev. George Peacock has undertaken to present to the next meeting, a report on the recent progress of Mathematical Analysis, in reference particularly to the differential and integral calculus.

"2. Professor Airy has undertaken a report on the state and progress of Astronomical science, in reference particularly to Physical Astronomy.

"3. J. W. Lubbock, Esq. has consented to furnish such information respecting the data and desiderata for calculating the time and height of High-Water as he may be able to offer.

"4. James D. Forbes, Esq. has undertaken to present a report on the present state of Meteorological science.

"5. Dr. Brewster has undertaken a report on the progress of Optical science.

"6. The Rev. Robert Willis has undertaken a report on the state of our knowledge concerning the Phenomena of Sound, in reference especially to the additions recently made to it.

"7. The Rev. Professor Powell has undertaken a similar report respecting the Phenomena of Heat.

"8. The Rev. Professor Cumming has undertaken a report on Thermo-Electricity, and on the allied subjects in reference to the discoveries recently made in them.

"9. James F. W. Johnston, Esq. has undertaken a report on the recent progress of Chemical science, especially in foreign countries.

"10. The Rev. Professor Whewell has undertaken a report on the state and progress of Mineralogical science.

"11. Robert Stevenson, Esq. has undertaken the report recommended by the Geological and Geographical Committee, on the waste and extension of the land on the east coast of Britain, and on the question of the permanence of the relative level of the sea and land.

"12. Professor Lindley has undertaken to give an account of the principle questions recently settled, or still agitated, in the Philosophy of Botany."

No less than six of these twelve reports are to be contributed by eminent members of the University of Cambridge,—a circumstance certainly highly indicative of the warmth of feeling of that great body towards the objects of the British Association, as well as giving a pledge for the ability of the works thus undertaken. The former distinguished professor of mineralogy at Cambridge was among the earliest supporters of the plan, to which he alluded in a letter communicated to the York meeting, an extract from which is given in Mr. Vernon Harcourt's address. "A collection of reports," he

says, "concerning the present state of science, is on all accounts much wanted, in order that scientific students may know where to begin their labours, and in order that those who pursue one branch of science may know how to communicate with an inquirer in another. For want of this knowledge we perpetually find speculations published which show the greatest ignorance of what has been done and written on the subjects to which they refer, and which must give a very unfavourable impression of our acquirements to well-informed foreigners."—Report, p. 29.

The report is divided into three distinct portions, as the title page indicates. The first contains the proceedings of the meeting towards the constitution of the permanent body or association which sprung from it, and the subsequent arrangements necessary to its complete constitution. The second part embraces the proceedings of the general and the sub-committees appointed to carry into effect the objects of the Association, and which, it will be seen, were by no means limited to the week of the meeting at York. The third division contains the scientific transactions of the meeting at York, comprising the order and periods of the meetings, with abstracts of the papers presented. One communication, printed at full length, is the excellent essay of Dr. Henry, of Manchester, upon the philosophical character of Dr. Priestley.

It is not our intention to enter into any analysis of these several departments. But we feel it to be only due to the very able address of Mr. Vernon Harcourt, the real originator of the *permanent* association, to make one or two quotations from it; for we view it as an address differing much from what is too often found upon such occasions, as perfectly free from affectation, as abounding in the soundest views of the present state of science, and written in a manly and highly perspicuous style.

The following passage sets in a true light the bearing of the new association upon already existing societies:—"It is not by counting the great luminaries who may chance to shine in this year, or that,—in a decade of years, or a generation of men,—that we are to inform ourselves of the state of national science. Let us look rather to the numbers engaged effectually, though less conspicuously, in adding by degrees to our knowledge of nature; let us look to the increase of scientific transactions and journals; let us look, gentlemen, at the list produced this day of philosophical societies which have grown up in all parts of the kingdom. The multiplication of these new and numerous institutions indicates a wide extension of scientific pursuits. The funds so liberally contributed to their support bear evidence of an enlarged disposition in the public to promote such pursuits.

"It is on this very ground I rest the necessity and the practicability of establishing in science a new impulsive and directive force, that there are new and more abundant materials to be directed and impelled. The mining field of discovery seems to me to show, on the one part, the ore breaking out on every side; veins of the precious

metal scarcely opened or imperfectly wrought; and on the other a multitude of hands ready to work it, but no one engaging them to labour, or showing them in what manner they may employ their industry to the best advantage. And therefore it is that I propose to you to found an Association, including all the scientific strength of Great Britain, which shall employ a short period of every year in pointing out the lines of direction in which the researches of science should move, in indicating the particulars which most immediately demand investigation, in stating problems to be solved and data to be fixed, in assigning to every class of mind a definite task, and suggesting to its members, that there is here a shore of which the soundings should be more accurately taken, and there a line of coast along which a voyage of discovery should be made.

"I am not aware, gentlemen, that in executing such a plan we should intrude upon the province of any other institution. There is no society at present existing among us, which undertakes to lend any guidance to the individual efforts of its members, and there is none, perhaps, which can undertake it. Consider the difference, gentlemen, between the limited circle of any of our scientific councils, or even the annual meetings of our societies, and a meeting at which all the science of these kingdoms should be convened, which should be attended, as this first meeting you see already promises, by deputations from every other society, and in which foreign talent and character should be tempted to mingle with our own. With what a momentum would such an association urge on its purpose! what activity would it be capable of exciting! how powerfully would it attract and stimulate those minds, which either thirst for reputation or rejoice in the light and sunshine of truth!"

[TO BE CONTINUED.]

Notice of Electro-Magnetic Experiments.

[Communicated by Prof. A. D. BACHE, of the University of Pennsylvania.]

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN,—I send you a description of the apparatus for producing the spark from a magnet according to the method of Nobili, and for other recent and curious experiments on electro-magnetism, together with an account of their repetition. This is done that any one who may be desirous to repeat or to extend the experiments may, without delay, be put in possession of the means of so doing.

Extract of a letter from J. Saxton, of Philadelphia, to Isaiah Lukens, dated London, April 14th, 1832.

"You may have heard of Faraday's curious discovery in electro-magnetism. He has succeeded in obtaining from a magnet a spark

resembling the electric spark. The apparatus consisted of a copper plate mounted on an axis, like an electrical machine, and made to revolve between the poles of a large magnet. The plate used was about one foot in diameter, and one-eighth of an inch in thickness. The rim of the wheel was amalgamated, as well as a ring around the axis. Two pieces of copper, shaped to fit, for two or three inches, the amalgamated ring and the circle, were attached to either wire of a galvanometer. These pieces of copper being applied to the wheel, and the latter turned, the needle of the galvanometer vibrates: the amount of vibration may be increased by alternately touching and removing one of the plates. The copper plate which touches the rim should be between the poles of the magnet.

"I have made this experiment in a different way and succeeded satisfactorily. The method was as follows. A coil of wire wrapped with silk, similar to that used in the galvanometer, was attached by the ends to the wires of the galvanometer. On passing this roll backward and forward upon one of the poles of a horse-shoe magnet, or placing it upon and removing it from either pole, I have made the needle of the galvanometer spin round rapidly."

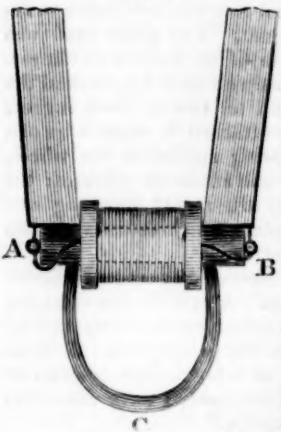
Extract of a second letter from J. Saxton, of Philadelphia, to Isaiah Lukens, dated London, May 11, 1832.

"Since my last I have heard of a method of producing a spark from a magnet, discovered, I believe, by an Italian. This experiment I made at once upon a large horse-shoe magnet which I am making for Mr. Perkins and his partners. One of your large magnets will answer the same purpose. Make a cylinder of soft iron of an inch, or three-fourths of an inch, in diameter, and of the usual length of the keeper; place two disks of brass or wood upon this cylinder, and at such a distance apart that they will conveniently pass between the poles of the magnet; between these wind, say fifty feet of, bobbin wire, which may be of iron covered with cotton; let the ends of this coil be bent over the ends of the cylinder and brought down until they touch the poles of the magnet, the ends should be of such a length that on bringing the cylinder to the magnet, one of the ends will touch when the cylinder is about half an inch from the magnet, and the other at one-fourth of an inch. The cylinder being thus arranged, and in contact with the magnet, on drawing it suddenly away a spark will pass between the end of the wire and the pole of the magnet."

The apparatus alluded to in these letters was, soon after their receipt, put together by Messrs. Isaiah Lukens and Benjamin Say; it is figured in the cuts which follow.

Fig. 1 represents the apparatus of Nobili for procuring the spark

Fig. 1.



from a magnet. A, B, is a cylinder of soft iron, upon this are two brass rims, between which bobbin wire (wrapped wire of iron and copper were both successfully used,) is wound; the ends of the wire coil are carried out at the opposite ends of the cylinder, and being bent downwards pass through holes in two brass (or wooden) pins. The spring of the wire causes both the ends to touch the magnet when the keeper is attached, when it is withdrawn one end projects beyond the other.*

This apparatus has been improved by Mr. Lukens by coiling the ends of the wire into a spiral, thus forming a spring to press the points of the wire against the poles of the magnet; and by carefully insulating the ends in their passage through the brass stems.

From this improved apparatus a spark can be obtained on *removing* the keeper with seldom a case of failure; frequently two sparks appear, one at each end of the wire, and in some experiments of Messrs. Lukens and Say a third spark was seen to pass from one of the brass rings. I have very frequently obtained sparks also by rapidly *replacing* the keeper.

To ascertain the nature of this spark, I endeavoured to determine whether the removal of the keeper which produces the spark was attended with any electrical effect which would warrant the supposition that this was an electric spark.

The cylindrical keeper, arranged as at first described, was used for this purpose. The ends of the wires spoken of as touching the poles of the magnet were bent outwards, to remove them from the poles, and connected with the wires of a galvanometer. On approaching the keeper to, or drawing it from, the magnet, an agitation of the needle of the galvanometer was produced, demonstrating the existence of a current of galvanic electricity, to which, therefore, the spark is probably due.

A few turns, say four or five, of iron bonnet wire about the keeper of a magnet, which supported, by a contact with its whole surface, fifty pounds, produced a very sensible vibration in the needle: the contact and removal being made at times tending to increase the arc.

In the experiments of MM. Nobili and Antinori, the account of which has been received since those which I have described were made, it seems that this development of a galvanic current which they observed led them first to suspect that the spark might be obtained.

The following observations were made at the same time with those above described, on the direction of the galvanic current. The needle of the galvanometer used, was suspended by a fibre of silk; upon the

* This condition appears by subsequent experiment to be by no means essential.

stand of the instrument were two brass cups in the same plane with the coils of the wire surrounding the needle; into the cup corresponding to the south pole of the needle, the wire passing from south to north *above* the needle, and from north to south below, was placed; into the north cup was inserted the opposite wire. Thus arranged, a current of galvanism passing from south to north will deflect the north pole of the needle to the west; by a current passing from north to south the north pole of the needle will be deflected to the east. The galvanometer was covered by a glass receiver to prevent agitation from currents of air. The magnet used was the one alluded to above as supporting fifty pounds, this is a horse-shoe magnet, made of ten magnetic bars, the keeper being filed off in front applied itself to two of these.

The magnet being placed with its poles to the south, (the north pole being westward) the keeper was brought to the magnet in such a position that the coil was directed *above* the cylinder from *north to south; below* from *south to north;* the wire from the *upper side* was dipped into the mercury of the *south* cup of the galvanometer; the wire from the *under* side into the *north* cup.

On drawing the keeper from the magnet, the north pole of the needle of the galvanometer passed to the west; the needle being allowed to return to the meridian, a return of the keeper to the magnet deflected the north pole to the east. By assisting the needle in its vibrations by the alternate withdrawal and return of the keeper, a very considerable vibration was produced.

By changing the keeper from right to left so that the wire passing *over* the cylinder was directed from *south to north*, the communications with the galvanometer remaining as before, the reverse of the deflections just described took place.

The effects described may be represented by a galvanic current circulating around the keeper, and at right angles to its axis, directed from north to south above the cylinder when the keeper was withdrawn, in the contrary direction when it was returned. Such a current would evidently have passed out of the upper wire on the withdrawal of the keeper, and out of the under wire on its return; that is, would have passed from south to north, above the needle of the galvanometer, in the first case, and from north to south in the second.

Fig. 2.

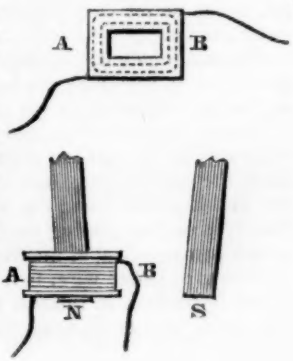


Fig. 2 shows the apparatus for producing vibration in the needle of the galvanometer by the wire coil and magnet. A, B, is a roll of wrapped wire wound about a wooden spool, which has the central part removed; the ends of the wire are connected with the wires of a galvanometer; this roll is represented in the lower part of the figure as placed upon the north pole of a horse-shoe magnet, by passing it to and fro

upon the leg of the magnet, or by alternately removing and replacing it upon the pole, a vibration is produced in the needle of the galvanometer. The wires are continued to such a length as to prevent the direct action of the magnet upon the needle of the galvanometer.

Some experiments which, by the kindness of Mr. Lukens, I was enabled to make with this apparatus, resulted in a satisfactory mode of representing the effect which is produced upon the galvanometer in any given position of the coil. I offer it simply as a mode of recollecting the results of observation.

The coil of wire (fig. 2,) was first applied to the north pole of the magnet, the direction of the coil being from right to left above the magnet, the inside wire of the coil was on the left hand, the outside wire on the right, the experimenter facing the north; the outside wire was carried to the south cup of the galvanic multiplier, the inside to the north cup. The poles of the magnet were turned to the south. On withdrawing the coil from the pole, the north pole of the needle was deflected to the west; returning the coil, carried the same pole to the east. Changing the wires of the coil in the cups of the galvanometer reversed the direction of the vibration of its needle.

The effect of withdrawing the coil would have been produced by a galvanic current passing through the coil from left to right below the magnet, from right to left above it.

The coil was next changed from right to left; that is, the direction of the coil changed so that it passed from right to left below the magnet, and from left to right above it; the wires which dipped into the cups of the multiplier remained in their places; the inner wire was now to the right hand, the outer wire to the left. On removing the coil from the north pole of the magnet, the north pole of the needle of the multiplier passed to the east, on returning the coil the same pole moved to the west.

This effect would (as before,) have been produced by a galvanic current passing from left to right below the magnet, from right to left above it. The other positions of the coil being examined showed that they might be represented by the same supposition of a circular current about the pole of the magnet, and passing through the wire. The reverse of such an hypothesis is of common application to represent the action of the conjunctive wire of a galvanic battery upon a magnetic needle.

The south pole of the magnet presented opposite results, the effects produced by removing the coil were such as would have occurred in replacing it upon the north pole.

As the removal of the coil produces a contrary effect from that obtained when it is placed upon the pole, the representation is complete from the opposite magnetic currents produced in these cases. When the coil is drawn along the magnet towards the north pole, it is easy to conceive that passing successively to more magnetic parts, or exposed to magnetism of different intensities, the current of magnetism, with regard to the wire, is from south to north; this, by the reversion of the hypothesis in relation to the galvanic current, produces (since the north pole is towards the operator,) an electrical current from

west to east, or from left to right, below the magnet. The same is true for the south pole.

We conclude that the effects of a magnet upon a coil of wire may be represented by an electrical current at right angles to the direction in which the wire moves upon the magnet, and directed below the magnet from west to east when the coil is moved from the south pole to the north pole of the magnet, and vice versa, the poles of the magnet being turned to the south.

The denominations will change of course if it be considered more convenient to turn both poles to the north.

It would seem easy to bring the facts relating to the removal of the keeper upon which wire is coiled, under the same expression. In that case the magnetism is in motion with respect to the coil, leaving the soft iron which forms the keeper.

With fifteen turns of copper wire upon the prismatic keeper of the magnet before used, a vibration through twenty degrees, at the maximum, was produced; beyond this the power of the current could not carry the needle. The wire was wrapped with silk.

With five turns upon the same keeper a vibration through an arc of ten to twelve degrees was obtained.

The coil being at rest upon the magnet no permanent deflection is produced. This agrees with an observation of Nobili and Antinori.

The amount of vibration may easily be increased by providing two coils, one for each pole, the direction of the coils being opposite to each other, the outer wires of each coil being united as well as the inner ones, the effect of two coils would be produced. They may be separated by a piece of wood, to which being attached, and the wood provided with a handle, the coils may be removed or replaced very conveniently.

Fig. 3.

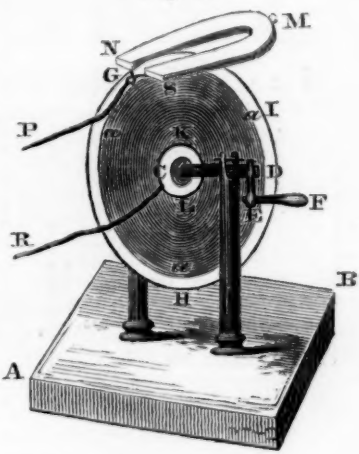


Fig. 3 represents Faraday's wheel; G, H, I, being a piece of copper 12 inches in diameter, the circular ring between G, H, I, and *a*, *a*, *a*, is amalgamated, also the ring K, L, near the centre of the plate on the same side with the first ring; the wheel is mounted upon an axis C, D, and turned by a winch. K, L, and G, are plates of copper, to apply the one at the amalgamated ring around the axis, the other at the ring at the circumference and between the poles, N and S, of a horse-shoe magnet. G, P, and C, R, are the wires soldered to these plates, their extremities connected with the galvanometer as described above, their length adjusted upon the same principles.

In experimenting with Faraday's wheel, the disk K, L, at the centre was pressed constantly against the wheel by fastening a cork between the disk and the support. The piece of copper G was touched to the wheel at intervals so as to assist the vibrations or to destroy them at pleasure. When the wheel was first amalgamated, a deflection in the needle was produced without the aid of the magnet; afterwards no such deflection was observed. Opposite rotations of the wheel produce opposite effects in deflecting the needle of the galvanometer, other parts remaining the same.

Meteorological Observations for May, 1832.

Moon. Days.		Therm. Sun rise.	Therm. 2 P. M.	Barometer. Sun rise.	Barometer. 2 P. M.	Dew point	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
	1	44°	63°	Inches. 29.84	Inches. 29.80	37	W.	Breeze.	Inches.	Cloudy—flying clouds.
	2	43	63	.90	.93	37	NE. W.	Light.		Clear day.
	3	41	66	.93	.93	40	SE. S.	Calm.		Lightly cloudy—clear.
	4	47	76	.80	.70	61	SE. S.	Blustering.		Light clouds—clear—rain
	5	61	59	.60	.60	46	W. NW.	Moderate.	.13	Cloudy day. [in night
	6	45	67	30.00	30.10	37	NW. SW.	do.		Lightly cloudy—clear.
	7	42	67	.95	.95	34	SE.	do.		Foggy—clear.
	8	48	76	.20	.10	54	SE. S.	do.		Cloudy—light clouds
	9	56	72	.10	.10	57	S. W.	Breeze.	.95	Rain—cloudy.
	10	52	74	.20	.25	34	NE. SE.	do.		Light clouds—clear.
	11	42	68	.35	.40	29	NE. SSE.	do.		Clear day.
	12	42	75	.30	.30	32	SE. SW.	do.		Clear day.
	13	50	78	.10	.20	53	SW.	do.		Clear—overcast.
	14	60	80	.00	29.95	63	S.	do.		Cloudy—showery.
	15	69	69	29.83	.74	63	S.	do.		Showers—rain.
	16	54	78	.90	.80	50	W. NW.	Blustering.	.50	Lightly cl'dy—fly'g. cl'ds
	17	55	79	.80	.90	49	NNE. W.	Moderate.	.09	Clear day—rain in night.
	18	59	78	.80	.90	59	SW.	do.	.03	Cl'dy—fl'g cl'ds—rain n't
	19	57	84	.60	.70	65	SE.	Blustering.	2.00	Cl'dy—fl'g cld's—thund.
	20	57	56	.60	.60	56	SW. W.	Moderate.	.17	Cl'dy—showery. [r'n. hail.
	21	46	68	.60	.64	33	W.	Blustering.		Clear day.
	22	47	71	.83	.83	34	W.	Moderate.		Clear day.
	23	48	60	.90	.90	43	SSE. E.	do.		Light clouds—cl'dy—rain.
	24	45	46	.90	.70	43	E. E.	do.	1.15	Rainy day.
	25	43	64	.80	.80	40	NW.	do.		Cloudy—flying clouds.
	26	56	64	.70	.80	40	NW.	do.	.65	Clear—rain.
	27	44	64	.40	.50	35	W. NW.	do.		Clear—flying clouds.
	28	45	66	.70	.75	44	W.	do.		Clear—flying clouds.
	29	50	79	.84	.90	44	W.	do.		Clear day.
	30	56	56	.90	.90	53	W.	Blustering.		Rain—showery.
	31	57	57	.55	.50	46	E.	do.	.45	Rain—cloudy.
	Mean	49.47	66.77	29.85	29.87	46.7			5.42	

	Thermometer.	Barometer.
Maximum height during the month,	84. on 19th.	30.40 on 11th.
Minimum do.	41. on 3d.	29.40 on 27th,
Mean do.	58.12	29.86